

February 1, 1960

Aviation Week

and *Space Technology*

Plug Nozzle
Rocket Details

Bids Due On
Mach 2 VTOL

A McGraw-Hill Publication

Improved Thor Launch



Reaching for the Moon, Mr Designer?

Here's a tip... Millions of Kaylock® men ago, a new aircraft fastener made its bow—the Kaylock H10, first lightweight, high tensile, all-metal, self-locking nut.

Its significant improvement over then-existing fasteners—lighter weight, greater strength, smaller envelope—won immediate acceptance by aircraft weight engineers and designers.

Today, with a premium on weight and space savings in aero-space vehicles and engines, design engineers depend more than ever on Kaylock nuts. So here's a tip...

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Fastener with a past—that's the Kaylock H10. A favorite choice of design engineers for the past 2 years, the H10 was the first high tensile, all-metal nut using the alloy steel self-locking principle for which Kaylock nuts are known. "Fast answers" include:



Service Temperature: 300°F
Tensile Strength: 150,000 PSI
Material: Alloy Steel

Ready to Help—Here are a few of the Kaylock material working nuts built to meet rigid requirements in weight and space reduction.



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H22 Service Temperature: 300°F
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Material: Alloy Steel



H24 Service Temperature: 300°F
Tensile Strength: 200,000 PSI
Material: Alloy Steel



H41 Service Temperature: 300°F
Tensile Strength: 150,000 PSI
Material: Alloy Steel



H33 Service Temperature: 300°F
Tensile Strength: 200,000 PSI
Material: Alloy Steel



H1023 Service Temperature: 300°F
Tensile Strength: 150,000 PSI
Material: Alloy Steel



H10 Service Temperature: 300°F
Tensile Strength: 200,000 PSI
Material: Alloy Steel



H20 Service Temperature: 300°F
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2. Extreme pressure changes during supersonic flight are calling for aerospace materials of greater structural strength. Stretched acrylic plastics can meet this requirement.
3. Canopy bubbles are being designed for optimum performance using compound curvatures. Thus, the enclosure materials must be capable of being formed to contours without losing desired properties. Certain processes fulfill this need.



Not until now, however, has one product met all three requirements of supersonic flight without sacrifice in optical quality. Its name: THERMOSHIELD. It was developed and is now being produced by Goodyear Aircraft, a pioneer in the field of stretched acrylics and high temperature laminates.

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The result: a major advance in the state of the art.

Now—THERMOSHIELD can extend the temperature limits of transparent canopy bubbles from Mach II to Mach III.

Now—THERMOSHIELD can bring new protection to supersonic aircraft requiring one-piece canopies of compound curvatures.

Now—THERMOSHIELD can be used as an impact-resistant barrier for transparent canopies and windshields aloft—or as a face guard for military troops on the ground.

For more information on this major advance in engineered plastics—write Goodyear Aircraft Corporation, Dept. 916AN, Akron 15, Ohio.

Thermoshield, F-3, Goodyear Aircraft Corporation, Akron 15, Ohio

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AVIATION CALENDAR

(Continued from page 7)

Coventry of Bearings, American Society of Mechanical Engineers, Lubrication Division, Engineering Standards Building Administration, New York, N. Y.

Mar. 17-18—Squad Design and Testing Symposium, Department of Commerce, Washington, D. C. Sponsor: Department of the Navy, Bureau of Naval Weapons.

Mar. 21-24—Institute of Radio Engineers' International Convention, Waldorf Astoria and Coliseum, New York, N. Y.

Mar. 23-25—Symposium on Optical Spectroscopy, Measurement of High Temperature, University of Chicago, Chicago. (S) Sponser: University of Chicago Applied Science Laboratories, Jernell Hall, Chgo., National Science Foundation.

Mar. 24-25—First Annual Symposium on Human Factors in Electronics, New York, N. Y. Sponser: Institute of Radio Engineers Professional Group on Human Factors in Electronics.

Apr. 4-5—Fourth Colloquium, Combustion and Propulsion Panel, Advisory Group for Aeronautical Research and Development, N.A.T.O., Milan, Italy. Subject: High Mach Number Air Breathing Engines.

Apr. 14-15—1968 National Aeronautic Meeting and Mission and Aircraft Engineering Display, Society of Automotive Engineers, Commodore Hotel, New York, N. Y.

Apr. 16-18—Structural Design of Space Vehicle Conference, Edinboro Hotel, Santa Barbara, Calif. Sponser: American Rocket Society's Structures and Materials Committee.

Apr. 18-19—1968 National Meeting "Hypersonic—Space Frontier," Institute of Environmental Sciences, Sheraton Hotel, Los Angeles, Calif.

Apr. 22-19—1968 Annual Spring Technical Conference, Institute of Radio Engineers in cooperation with the American Rocket Society, Hotel Alamo, Cincinnati, Ohio.

Apr. 19-21—International Symposium on Active Networks and Feedback Systems Engineering Sciences Bldg., New York, N. Y. Sponser: Polytechnic Institute of Brooklyn, Department of Defense Research Agency, Institute of Radio Engineers.

Apr. 20-22—National Symposium on Manual Space Stations, Institute of Environmental Sciences, Ambassador Hotel, Los Angeles, Calif. Sponser: NASA, the Rand Corp.

Apr. 21—Annual Eastern Regional Meeting, Institute of Navigation, Key Bldg., Marriott Main Bldg., Washington, D. C.

Apr. 28-30—Southwest Vitals & Materials Conference "Vitals and Materials for the Space Age," American Institute of Virology, Memphis and Pasadena Engineers, Ambassador Hotel, Los Angeles.

Apr. 27-28—National Meeting on Space Age Materials, Cincinnati Chapter of the American Society for Metals, Sheraton Gibson Hotel, Cincinnati, Ohio.

May 2-4—National Aeronautical Electronics Conference, Edinboro and Marriott Bldgs., Santa Barbara, Calif. Sponser: Institute of Radio Engineers Professional Group on Aeronautical and Navigational Electronics.



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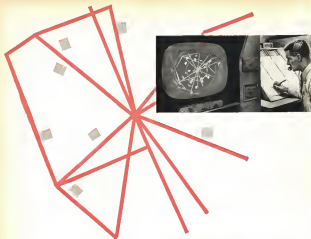
To produce experiences for the Hercules, Lockheed called on Avco/Nashville. Long experience in aircraft tooling by the Nashville Division assured Lockheed of positive fidelity to design, uniform quality, perfect interchangeability.

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For more information on the Nashville Division's capabilities in aircraft, missiles, and ground support structures, write: General Marketing Manager—Structures, Nashville Division, Avco Corporation, Nashville, Tennessee.





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Once again RCA Tube Engineers have provided another practical answer to the long-standing problem of multi-screen radar display in brightly lighted rooms. The answer . . . RCA-7539 Scan-Conversion Tube.

The 7539 is designed to transform signal information continuously from one frame base to another. For example, PPI information generated by a conventional radar system can be processed by this tube for display on a high-resolution, large-screen TV monitor for comfortable viewing in a brightly lighted room.

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For complete information about RCA-7539 and its possible applications, contact the RCA Field Office nearest you. Technical literature for the 7539 will be available about January 15. For a free copy, write RCA Commercial Engineering, Section B-115 Q, Hickory Hall, N. J. 07033. Another way RCA serves you through Electronics

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EDITORIAL

The Space Debate

The great debate over the United States' space exploration program and its military and civil applications has begun on Capitol Hill before the House Science and Astronautics Committee with representatives already testifying from the Pentagon, NASA, State Department and White House. It is too early to sift through the editorial fog generated by this debate and evaluate the lead facts that may emerge as to where we are going, how fast and why in our military and civil space program.

The most disturbing symptom already apparent in this debate is the widely diverging viewpoints as to the value and need for space research from various executive agencies of the government. It is apparent from President Eisenhower's latest public statements that he is still unconvinced that space exploration has any real significance for the United States, either in military applications or as a vindicator of international prestige. Yet, George Allen, head of the U. S. Information Agency, and Lawrence Merchant, Undersecretary of State, have both testified in considerable detail on how the impact of Soviet space achievements in contrast to our own has seriously affected U. S. prestige abroad and influenced the attitudes of our friends, foes and the neutrals.

Initial Task

Clearly, the first task in any major improvement of our space effort is to convert the very top level of our national leadership that space research is not just an expensive toy or scientific faddism. The current White House attitude toward space more than two years after Sputnik I is evidenced by the shocking proposal of Budget Director Maurice Stans that the NASA Fiscal 1961 budget remain at the same level as the previous year when the agency was just coming into being. Presumably, White House staff men expect their counterpart for the entire space venture and grow angry over the modest number of dollars that are now being spent for this program. Another discouraging aspect of the space picture is the conduct of the House Science and Astronautics Committee under the chairmanship of Rep. Overton Brooks (D-La.). This committee can and should be a responsible group functioning in a manner to guide a solid contribution to public understanding of the space program and provide legislative support for the executive agencies engaged in it.

Dictatorial Operation

However, the heavy-handed, dictatorial and technically untrained operations of Chairman Brooks are seriously jeopardizing the usefulness of this committee. In an apparently ungrudging attempt to control personal publicity, he has refused to allow any of the subcommittee to function effectively and, on this account alone, has brought the committee close to open revolt against his tactics.

He has failed to appoint a technically qualified professional staff, without which the committee cannot hope

to be taken seriously, and has apparently used ineptness in his latest attempt of Shensport, La., as the sole justification for what staff appointments have been made. This failure to provide the committee with a technically qualified staff and the current practice of Chairman Brooks forbidding staff members to provide questions to other committee members has turned the current hearings into a series of petty squabbles and allowed them to drift into barren technical stagnancy rather than keeping sharply in the mainstream of current space problems.

Many criticisms were initially expressed over the Democratic congressional maneuver that edged Mr. Brooks off the Armed Services Committee into the chairmanship of the newly-created Science and Astronautics Committee. The feeling was that he would be unable to rise above the old-fashioned attitudes of a hazy, distant politician and fail to meet the challenge offered by the chairmanship of this modern and extremely significant new committee. Even at this late date, it is possible for Mr. Brooks to achieve the situation and return his committee to the useful role it played earlier as a temporary group under the leadership of Majority Leader Rep. John McClellan (D-Miss.) by using the procedure that most other successful congressional committees employ and allowing his willing colleagues to share the workload, even though they may also share the spotlight with the chairman.

Without a fundamental change in Mr. Brooks' handling of the committee, it can hardly hope to make any useful contribution and will only serve to waste the time of responsible government and industry leaders in connection with its potential backlogs. This is hardly a partisan matter since committee members of both parties are equally unhappy with their chairman's leadership.

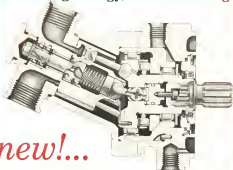
New Service Relationship

Meanwhile, an optimistic note is developing in the Pentagon where the level Air Force and Navy officials are meeting quickly to resolve their space problems and arrange an orderly program that will provide both these services with their operational requirements for space vehicles. Hopefully, this spirit and technique that is now beginning to emerge at top levels in the Pentagon also can be extended to the Pacific Missile Range before the accidents and wasteful inter-service rivalry there produce another expensive and unnecessary loss.

The space debate will accept most of the first half of the year, and it will indeed be difficult to penetrate the fog generated by executive indifference screened by the "executive privilege" to withhold from public view any embarrassing information regarding the NASA program and the actions of its officials. For an executive agency that was created with a legal mandate from Congress to keep the public informed on everything except specific military hardware, the NASA officials have weighed themselves in the blanket of official secrecy on the ground of "executive privilege" faster than any other group in official Washington.

—Robert Niles

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WHO'S WHERE

In the Front Office

Donald E. Gaudin, vice president, Executive Aviation Co., Seattle, Wash. Mr. Gaudin continues as assistant general manager of the company's Transport Division.

R. R. Everett, vice president-technical operations for the Malt Corp., Livingston, Mass. Also, **Ronan F. LaFollette**, director of the corporation's Washington, D. C., office.

Lucian J. Hunt, vice president in charge of Aerospace Affairs for Management and Engineering Center, Tulsa, Okla.

Charles Kuchner, vice president-office administration, Kansas Aircraft Corp., Overland Park, Kan.

Walter F. Kuehn, a director, Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Mr. Kuehn continues as a corporate vice president and head of the company's Military Products Group.

John F. King, president, Great Hydraulics, Inc., Los Angeles, Calif.

Donald W. Papp, corporate vice president, Swales Associates, Inc., Neshaminy, N. H., and George Rosen, vice president manufacturing, Aero Corp. Victor H. Sorek (USN, ret.), manager of special projects.

Dr. E. G. Pabst, vice president-Research and Systems Engineering Division, Aerospace Industries Laboratory, East Park, N. Y., and **Dr. G. G. Crambach**, vice president-Electronics Systems and Techniques Division.

Richard A. Whaley, Inc., San Carlos, Calif., has appointed the following as vice presidents: **Norman B. Robbins**, manager, Aircraft Products Division; **Joseph R. Green**, manager, Instrument Division; **Thomas E. Hubbard**, director, Research & Development Division.

George E. Hall and **F. F. Fontaine**, co-owners, vice presidents, Bendix Aviation Corp., Detroit, Mich. Also, **Dr. Russell D. O'Neil**, vice president-engineering, **Ray J. Stuchlik**, vice president, **Dr. O'Neil** as general manager of the Bendix Aviation Division, and **L. B. Young**, has been named assistant general manager.

Stanley E. Kendall, vice president and in-charge general manager, the Inflighttronics Co., Chicago, Ill.

Wesley E. Adams, vice president and assistant to the president, United Air Lines, Inc.

Dr. Marshall G. Holloway, vice president for research, the Budd Co., Philadelphia, Pa.

Honors and Elections

George T. Fox has been elected 1960 chairman of the Aerospace Industries Assn.'s Utility Airplane Council succeeding **James R. Kerr**, who also was elected a member of AIAA's board of governors. Mr. Fox is president of Aero Design & Engineering Co., and Mr. Kerr is president of the Lycoming and the Research and Advanced Development Divisions of Aero Corp. (Continued on p. 98)

INDUSTRY OBSERVER

► Air Force may make its decision this week between North American Aviation, Chance Vought and Convair proposals for development of the Shrike II missile manuevering low-altitude missile. High degree of mobility is being considered for Shrike, including launch from a transporter or via launcher.

► Massachusetts Institute of Technology's Lincoln Laboratories is conducting a study for National Aeronautics and Space Administration on the general subject of developing next-generation ICBM warheads from exploded-detonation-type pellets. Ruston Corp. is carrying out high-speed gas tunnel studies for MIT at NASA's Ames Laboratory on mounted trails of pellets tracking in excess of 20,000 fps.

► Air Materiel Command's Ballistic Missile Center, Ingleside, Calif., is taking a critical look at all of the budgetary aspects relating to USAF's ballistic missile programs. Major concerns are getting a particularly close out study to ensure that management and a number of other expenditures are within budgetary limits. Management and subcontracting procedures also are being scrutinized.

► Air Force is planning a large note issue for the Atlas ICBM to incorporate a reduction with greater yield than that possible with the present SR-1 case. Wider, longer warheads can be accommodated by modifying the missile's adapter section. Convair also is studying the possibility of adapting stretch tanks for the Atlas, other conventional structures or cryogenics. Some officials believe the liquid oxygen case used with SR-1 as Atlas propellant can be converted to stretchers.

► Lack of storage facilities for the Atlas is becoming critical, and additional ones probably will be necessary at structural sites, development proving locations and at Convair's San Diego plant and other test facilities.

► Northrop's Northrup Division, Anaheim, Calif., is building digital automatic target intelligence equipment (DATIG) to replace the Pulse weapon system. Upit will continuously monitor and pinpoint trouble in the events for the 16 missiles located in each submarine and perform the launch-missile maintenance.

► Hinged wing tips on North American's Mach 3 bomber, which account for approximately one quarter of the wing area, are being tested for Mach 3 cruise condition. Gadget will accommodate four two-thrust core nozzles.

► Cook Electric Co. is preparing a submission you to be used for on-site checking of contractor equipment at Vandenberg AFB, Calif.

► U. S. Navy expects the Seaquest to have a nuclear-powered submarine in the water and underway on sea trials within the next 12 months.

► Air Force living hours will decrease to 6,073,584 in Fiscal 1961 under present planning, a decline of 230,514 hr. from the current budget year level and a drop of 609,619 hours Fiscal 1959.

► USAF expects to spend \$710,000,000 for contract maintenance of missiles and aircraft at the depot level in Fiscal 1961. Trend in both types of maintenance is away from work on the complete article and toward overhaul of major components and increased work at times by terms set from depots. Until USAF's in-house capability for missile maintenance is substantially improved, the service will continue to rely heavily upon the work of outside contractors.

► USAF also plans to inactivate four U. S. depots in Fiscal 1961 as a result of a program to improve its logistic system by relocating supply activities at larger depots where maintenance facilities are available.

► Navy's Corvus air-to-surface standoff missile, which is scheduled to attain an initial operational status later this year, is now programmed to have a range in excess of 100 mi.



systems management problems?

As today's weapons and support systems become more and more complex, the need for teamwork and cooperation among contractors assumes

increasing importance. Hoffman, a pioneer in the development of the TEAM concept, has acquired a unique capability in systems management. Hoffman's ability to draw together the specialized talents of several organizations is demonstrated by the success of the eight-company "Tall Tom" Team for the U.S. Air Force—an example of how Hoffman can help solve your systems management problems.



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Washington Roundup

NASA Contracts Under Fire

General Accounting Office charged last week that National Aeronautics and Space Administration has hindered its investigation of those two major contract awards by refusing to let GAO personnel see key documents.

- \$502 million contract to Rocketdyne Division of North American Aviation for the development of a rocket engine with a 1.5-million-lb thrust capability.
- \$28 million contract with McDonnell Aircraft Corp. for advanced satellite capsules to be used in Project Mercury.

Robert Keller, GAO general counsel, told the House Space Committee that NASA has permitted GAO to see the documents concerning its small contract awards—such as a \$700,000 contract for Little Joe boosters—here the selection of the contractor was made by a subcommittee official.

Specifically, GAO wants to review the reports and recommendations of the source selection boards on the rocket engine and Mercury projects which presented were the basis of selection of contractors in T. Keith Glavin, NASA administrator. There were full competition with Rocketdyne for the engine contract. Of the 12 bidders for the Mercury contract, a House Space Committee report said, McDonnell was 10th lowest.

NASA Appointments

Abraham Ilavitz will be named deputy director for launch vehicle programs at National Aeronautics and Space Administration headquarters here. Director is USAF Maj. Gen. Douglas B. McInnes. Assistant directors will include Elliot Mitchell for projects and Malcom W. Rosen for vehicles. No assistant director for launch operations has been chosen. Ilavitz was assistant director for propulsion before the new launch vehicle program office was created. Mitchell was chief of the solid rocket development program and Rosen was chief of rocket vehicle development.

Others to be named in the new office are USAF Col. D. H. Horton, as technical assistant to the director, John R. Shalvey, assistant to the director. Elton Elfi, analysis and requirements, and chief of a budget and programming office.

Science in Politics

Seventeen scientists, noting the "strong interaction" between science and politics, formally announced last week that they would actively participate in this year's election campaign as advisors to the Democratic National Committee.

Headed by Dr. Ernest C. Pollard, chairman of the Yale University Physics Department, the group has an evaluation of the space program under way.

Noting that in the past scientists have taken political action "when they have had a strong motivation to do so"—proposing development of the atomic bomb during World War II, advocating civilian control of atomic energy after the war, highlighting the hazards of radioactive fallout—they said:

"We are aware that we are bringing new ground in longstanding relationship between science and politics. To those of us who are participating in this new venture, it appears that developments so revolutionary as the

Asorb, the Elorah, and the ICBM make it mandatory that new techniques in government must be tried."

Defense Brass Confirmed

Senate confirmed the new top management of Defense Department last week with no more than brief congressional remarks by Sen. Lyndon Johnson (D-Tex.), majority leader, who has led Democratic attacks on the Administration's "new outlook on the Soviet military challenge. Those confirmed: Thomas S. Gates Jr., secretary of defense, James H. Douglas, deputy secretary of defense, Dudley G. Sharp, secretary of the Air Force.

Johnson commented: "I know Mr. Gates and have respect and regard for him, and wish him well in this new assignment." He congratulated the President on the election of Mr. Douglas. He had a distinguished record as secretary of the Air Force. "I am delighted he has agreed to accept the increased responsibility of deputy secretary of defense." The Armed Services Committee gave careful thought to the qualifications of Mr. Sharp, and reported the nomination favorably.

Russian Strategy Planning

Role of the military in the Soviet Union is limited to giving "peaceful criticism" to the Communist leadership, according to a staff study on national policy published in the USSR, prepared by a Soviet Government Operations Subcommittee headed by Sen. Henry Jackson (D-Wash.).

"Should the regime wish to reduce the armaments build-up, the military would hardly obstruct the decision," the study said. "In any case, it is doubtful that with the present system of party control the military could ever become an organized element in opposition."

"On the other hand, during the past few years the question of military doctrine—how a war will be fought—has largely reverted to the military professionals. That change since the death of Stalin in 1953 is striking. While the old doctrine was being questioned, the only great gains, military sector was stagnating."

Soviet Bomber Threat

Meanwhile, Air Force Chief of Staff Thomas D. White warned the Senate Armed Services Committee last week against taking the pronouncedness of Soviet Premier Nikita Khrushchev in conventional weapons too seriously. Gen. White said:

"The Soviet aircraft threat is increasingly growing, diversified, sophisticated and more varied. Despite Mr. Khrushchev's latest propaganda blast regarding assault, the Soviet air force is the USSR's most dangerous weapon. We know that their air force is well maintained, has an excellent and expanding air base structure and that it is given high priority in the development and supply of new and better equipment. Agreeing their bomber strength is a rapidly growing airborne and intercontinental range ballistic missile force."

"Because of this increasing missile force, there has been a tendency on the part of some to overlook or to downplay Soviet aircraft strength. However, there is every indication that this force will remain powerful and will continue to perform as an integral part of Soviet strategic striking power."

—Washington staff

Plug Nozzle Rockets Show Space, Missile Promise

Washington—Plug nozzle rocket on gas now under intensive investigation by at least four major companies shows considerable promise for rockets and space vehicles and could make their first appearance as early as the Saturn 150,000-lb thrust hydrogen engine competition which opens this month.

National Aeronautics and Space Administration is not expected to specify that the Saturn engines use the plug nozzle concept, but at least one competitor—General Electric—has based its entire proposal on use of a segmented, "building block" engine employing a plug nozzle.

Two other—Rocketdyne Division of North American Aviation, Inc., and Aerojet General Corp.—are prepared to offer both plug nozzle and conventional nozzle designs if NASA's Saturn specifications permit. Aerojet is believed to favor the segmented combustion chamber design along with GE, but Rocketdyne apparently is taking a different approach.

The only plug nozzle application known to be flying now is in the Pratt & Whitney J52 turbojet which powers the North American F-105 fighter jet.

Plug nozzles offer a number of theoretical advantages over conventional nozzles and research to date—particularly in the past year and a half—indicates that all these advantages are obtainable in practice. This research, which has included both model and large-scale firings, also indicates there are no major technical hurdles left to be overcome, and that the nozzle concept is ready for incorporation in a specific development project.

A plug nozzle essentially is a conventional non-convergent-divergent nozzle formed inside a cone. In the bell-shaped De Laval nozzle common to most present rocket engines, supersonic expansion of the exhaust flow takes place internally. In the plug nozzle engine, exhaust gases produced by combustion in an annular chamber very near the base of the vehicle flow outward along a conical or conical plug or spike and most of the supersonic expansion takes place externally. The plug surface itself forms the boundaries for the surrounding flow, and the atmosphere forms the other.

Some early plug nozzle investigation was done by German rocket scientists before the end of World War II. First serious investigations in this country go back at least to 1934 and were done in connection with both turbojet powerplants for aircraft and rocket engines.

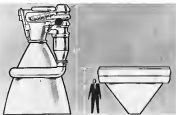
Most of the early U. S. research was conducted by what was then the

Low Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics. Although several companies looked into plug nozzle design at about this time, intensive work has been done by industry only in the past several years—some of it admittedly spurred by GE's strong interest in this type of design.

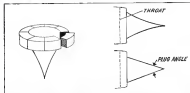
Advantages claimed for plug nozzle engines include:

- **Segmented engine**, which is an annular combustion chamber divided in half into a number of small cells allows testing of cells at full size, rather than in scale, and combining of cells to achieve engines of any desired thrust level. Use of segments avoids the combustion instability problems usually associated in trying to scale a convergent-divergent nozzle to make a large single chamber engine. Since the engine, although it is made up of separate cells, is a single engine, complexities that accompany clustering of a number of conventional engines are avoided. These include flow problems and interference of columns.

- **Better performance** than a conventional nozzle before the design becomes rich, which means an increase in performance from sea level to design altitude. Plug nozzles also switch performance of conventional engines at and above design altitude almost identically, so no performance penalty is paid for the gain at lower altitudes. Nozzle performance depends upon the ratio of pressure inside the combustion chamber to pressure outside, and the ratio of nozzle throat area to nozzle exit area. Effective exit area of the plug nozzle is the flow area at the tip of the plug. Since there is no constricted restriction on the flow, it expands until the radial

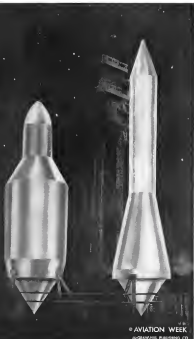
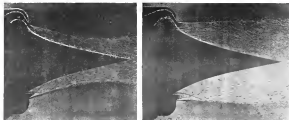


GENERAL ELECTRIC estimate of the relative size of million pound thrust plug nozzles and conventional engines using convergent-divergent and plug nozzles is shown above. Use of a segmented combustion chamber in the plug nozzle engine would allow vehicle control to be effected without guiding of the main engine or the use of smaller control rockets.



ANNULAR SHAPED segmented combustion chamber design which can be used in plug nozzles is shown at left. Two large plug shapes, the second shown and indicated as "booster" (upper) at right. Short plug with high plug angle is best for high altitudes.

NATURAL ADJUSTMENT of plug nozzle exhaust flow to external pressure conditions are shown in photograph pictures below with sea level conditions left and high altitude right. This shows a plug nozzle (see space) to be used at sea level with very small losses.



ARTIST'S CONCEPTION above shows two large vehicles using plug nozzle rocket engines of more than two million pounds thrust in the first stage. Low losses into vehicle at left has high acceleration drag but is being discussed with increasing desire for large rockets in that body loading moments will be reduced and structural weight minimized. This is especially important in the rocket is used to boost winged vehicles of the B-58 type. NASA tests have shown that the drag of the vehicle has less a major effect on the performance of a plug nozzle. The boat shaped base of the vehicle at left is preferred for most applications because it allows the external flow around the vehicle, and the rocket exhaust to run more evenly. Plug nozzle engines also are being considered for the upper stages of this class of vehicles.



PLUG NOZZLE as an operational subopt engine installation is shown above on the Hoard Dog powered by a Pratt & Whitney J12.

pressure in the flow equals the static pressure of the surrounding atmosphere. This varying "exit" area interests is a variable nozzle that adjusts itself to optimum performance at any altitude.

This low-altitude advantage is more useful for booster applications than for upper stages. A number of engineers familiar with plug nozzle work believe all large boosters beyond the Saturn external booster and the reusable delta E-1 Sounding III engine will require some variation of plug nozzle.

• **Scalable size.** Thus, a conventional engine producing the same amount of thrust. Plug nozzle designs are slend, compact and compare favorably in weight. These advantages would be particularly applicable to use in Saturn's hydrogen-fueled upper stages. The low density of the hydrogen fuel will require somewhat larger stage designs in order to contain the volume needed without making the stage so long and thin that bending loads and structural weight would be prohibitive. Under present planning, Saturn will have a 250-in. diameter first stage. Second upper stages will have 250-in. diameters.

• **Thrust vector control** without gimbal. Increasing structural division in an aft of a segmented engine and lowering it so when produces area dynamic thrust vector control. This decreases plugging structure and permits rigid construction between the engine and the vehicle.

• **Reduced flow resistance** around the base of a vehicle. Cleaner after end of the vehicle, permitted by the lack of need for gimbaling and by the fact that the nozzle throat flow at the base of the nozzle almost fills the area around it, behind the nozzle, greatly decreases the problem of interaction between external flow around the vehicle and flow of the exhaust.

Two other advantages are claimed that would be extremely important where space and weight programs are constrained—shorter development time and cheaper development cost. Although there is not any real agreement

on these two points, the most pessimistic estimates are that a plug nozzle engine could be developed in the same amount of time as a conventional one at a slight extra cost, or that it could be developed for the same money as a conventional engine with only some two to three months more time.

The two primary disadvantages or problem areas are:

- **Control of the plug.** This flow around the plug rather than along it can dump the shock wave often in the plug and keep the flow from expanding properly, cutting down the thrust coefficient. Varying the flow to change the thrust vector probably would complicate this problem.
- **Coaling of the plug.** Most estimates call for regenerative cooling. Some also call for coating the plug with an ablative material or making the entire plug of ablative material.

Saturn Bids Due

Washington—Some 20 companies have been asked to submit bids by Feb. 25 on development, construction, checkout, static test and delivery of second stage for the Saturn space vehicle following a lengthy bidder conference at Army Ballistic Missile Agency last week.

National Aeronautics and Space Administration is planning two, three, four and possible five-stage versions of Saturn. The second stage work is in the current competition with no less than Pratt & Whitney, 20,000-lb. thrust hydrogen engines. Companies invited to the conference included: Aero-Motion/Boeing Corp., Bell Aircraft Corp., Boeing Aerospace Corp., Boeing Aircraft Co., Chance Vought Aircraft, Inc., Chrysler Corp., Cosair Administration Division, Douglas Aircraft Corp., Fordison, Inc. and Hughes Aircraft Co., Lockheed Aircraft Corp., Martin Co., McDonnell Aircraft Corp., North American Aviation, Inc., Northrop Corp., Rockwell Co., Sperry Rand Corp., United Aircraft Corp., Western Electric Corp.

There is considerable enthusiasm for the plug nozzle concept among those who have looked into it. There also is a feeling that NASA is not likely to want to risk possible unforeseen development problems of a plug nozzle engine at the same time that it is trying to obtain the first high-thrust hydrogen engine, especially when the Saturn engine is far upper stage use rather than for a booster.

Investigative work on plug nozzle concepts first for includes the following:

- **General Electric.** More than 100 tests since last March on injection and on operation of a 30,000-lb. thrust peroxide engine to verify extensive and fine combustion efficiency, thrust coefficients, nozzle performance, effect of short nozzles, thrust vector control, jet transfer on the plug, etc. These have been complemented by wind tunnel tests and a parallel program in models, and GE has completed a considerable release of system and mission studies of vehicles that would use such engines. The work has been done under the direction of Dr. Kurt Berrner, liquid rocket engineering manager for the Rocket Engine Section. Most of the work has been at the Mills Test Station near Schenectady, N. Y. In addition to having conducted substantial company-funded work over a seven-year period, GE has a \$400,000 NASA research and development contract awarded last March. GE apparently has not set plug nozzle engines with hydrogen as a goal. It has investigated both the straight conical plug and the non-tropic or cantilevered plug and both in fixed and variable expansion. Its program in NASA is now up for a 1.5 million-lb. booster was based on a plug nozzle.
- **Avco.** Three years of investigation. Approximately 1,500 test firings have been made using various plug designs, with area ratios ranging from 1 to 35 over pressure ratios up to 10. Significant thrusting and operation with air support but has been investigated. Thrusting and engine operation of several mil-

lion pounds thrust based on the plug nozzle has been proposed.

• **Rocketdyne.** More than 500 wind tunnel and hot firing tests in the past year. A modified Altus engine with a spike inserted has been run at thrusts of up to 40,000 lb. and can be pushed to an expected 50,000-60,000 lb. This "throat" consists of a plug nozzle engine includes both internal and external expansion. Use of a throat apparently does not decrease thrust coefficient but can decrease engine diameter when compared with a pure plug nozzle and reduce length compared with a conventional engine.

• **Pratt & Whitney.** First to use a plug nozzle as a production subopt engine. Pratt & Whitney has the benefit of experience with the J52 powering the Hoard Dog missile. Plug apparently was added to adapt the engine for greater efficiency at a variety of altitudes. P&W has investigated a number of different rocket nozzle configurations in connection with its hydrogen engine work at the Florida research and development plant.

Bennett's belief that a large plug nozzle engine can be developed quickly, and cheaply in comparison with a large conventional engine is based primarily on use of a combustion chamber in which combustion instabilities and oscillations are absolutely well understood.

In making conventional nozzles upward, oscillations that occurred primarily in a longitudinal direction are likely to be avoided by more distribution in tangential and radial directions.

GE decided to enter the combustion in such a way that an integrated engine could still result. Small, multi-developed units became the vehicle part of the combustion. When these are formed into an annular engine, a step injector concept replaces the usual conical combustion.

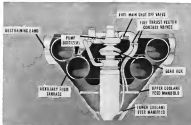
Investigators indicated that steady state oscillation modes could be suppressed if combustion chambers were kept small enough. Width was kept small enough to suppress radial oscillation modes. Developmental lengths because the instability for oscillations the tangential or circumferential mode. Proper longitudinal length was then selected from a longitudinal mode stability diagram obtained experimentally.

In one design considered by General Electric, this type of engine is located at the base of a plug nozzle. Liquid fuels are preheated, and before exhaust is brought out through the center of the nozzle.

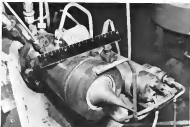
Application of plug nozzles to solid propellant engines also is being considered but it is not believed to have been given nearly as extensive investigation as possible application to liquid engines.



PIRING PHOTO above shows an Active plug nozzle under test. Drawing below shows the internal arrangement of a plug nozzle engine as suggested by General Electric. Nozzle throat is located under wing leading with short section of internal expansion flow before the exhaust reaches the plug.



LARGE INTERNAL volume of the plug allows it to house much of the rocket engine's auxiliary equipment and to house much of the main propellant gas for the main propellant under. Arranged and located below in typical case used in thrust tests. This scale is adequate for most flow studies of proposed combustion chambers.



Little Joe Tests Mercury Escape Cycle

By Craig Lewis

Wallops Island, Va.—National Aeronautics and Space Administration's fourth Little Joe test of the Project Mercury capsule (AW Jan. 25, p. 36) marked the first completely successful test of the escape system under the maximum aerodynamic loads expected in an actual emergency escape from the Atlas boosters.

Unlike an earlier maneuver on last test, the fourth Little Joe shot carried a monkey through the launch, escape and recovery cycle to test its physical reaction and performance under the stresses of the emergency escape maneuver. The monkey survived the test with no apparent ill effects.

The earlier maneuver on last test was the second in the Little Joe series (AW Nov. 9, p. 29), and it fell short of complete success when there was a 12 sec. delay between the time the ignition signal was sent to the escape rocket and the time the rocket actually ignited

and burned. In the fourth shot, the system was modified to send a stronger signal to the escape rocket, and it ignited as planned.

This latest shot was fourth in a planned series of six Little Joe tests of Mercury capsules under various conditions. Like the previous capsules, this ran a boobyplate model inside at Langley Research Center. The last test in the series is scheduled to use a capsule made by McDonnell Aircraft Corp.

McDonnell is manufacturing the operational capsule for the Mercury program.

Booster Configuration

Little Joe booster used in the fourth launch used only two Thiokol-Pollux solid propellant engines to push the 4-tonne rocket for the maximum air load test. Two Pollux chambers were carried by ballast. With two Thiokol Aerojets firing for 1.5 sec. at launch, the six engines developed 770,000 lb. thrust at liftoff. The Little Joe booster

and capsule weighed 25,000 lb. at take-off.

The Pollux engines burned out about 24 sec. after launch, and the vehicle reached a maximum speed of 1,300 mph.

At about 10 sec., the capsule reached a maximum dynamic pressure load of approximately 1,200 psi, that is, Mercury capsule reached maximum in an emergency attempt to leave the Atlas booster. When the capsule encountered these loads, pressure sensors signaled the Grand Central escape rocket, and it fired, carrying the capsule away from the booster and exposing about 20g loads on the monkey.

After separation, the capsule was scheduled to coast until the escape tower was detached at 32 sec. and the drogue chute was deployed at 99 sec. after launch. Gage data showed at about 10,000 ft.

The booster carried the capsule to 36,000 ft., where the escape rocket fired. It coasted to 46,000 ft. and landed in the Atlantic 12 mi. from Wallops where a Marine HUS helicopter from the Navy Mercury recovery unit picked it up. Over-correction for wind at launch caused the capsule to touch in altitude approximately 10,000 ft. higher than expected, and the wind caused the capsule and main chute to make farther out to sea than expected.

Psychomotor Test

Monkey was removed from its backpack about one hour after launch after spending 12 hr. in the capsule during countdown. The animal was a 6 lb., 40-month-old female rhesus monkey named Miss Sue supplied by the Air Force School of Aviation Medicine. It rode out its haul in a 114 lb. backpack and was scheduled to perform a single psychomotor test to measure performance under the stresses imposed by an escape under high dynamic pressure conditions.

Boobyplate was similar to the one used in the third Little Joe test which carried a monkey named Sam through a high altitude escape cycle (AW Dec. 14, p. 30).

In this last test, a red cue light was used to signal the monkey to pull a lever. If the lever was not pulled within two seconds after the light went out, the monkey got an electric shock. The light was timed to go back on one second after the lever was pulled.

The monkey was expected to perform its task about 100 times per minute.

It had been trained under all the



LITTLE JOE lifts off at Wallops Station site (above). Aboard is boobyplate monkey backup Project Mercury capsule to 45,900 ft. Monkey monkey was recovered in capsule.



MARINE HELICOPTER recovers boobyplate Mercury capsule containing monkey. Crewman was pole to third capsule landed 12 mi. from launch site. Before, pressing chamber of capsule in capsule after recovery from the Atlantic Ocean.



conditions that could be involved, including simulated parb in the backpack. There were four monkeys at Wallops Station before the test so that a substitution could be made if the chosen animal failed to pass her physical at the last minute.

There was no accelerometer on the monkey during the test flight, but second-instrument three channels of electrocardiogram measurements and two channels of air movement measurements, plus measurements of respiration, temperature and the content of the atmosphere in the backpack.

A boobyplate gage camera was used to photograph the monkey's face during the flight.

British, U.S. Agree On Satellite Plan

Washington—U.S. and British scientists reached a verbal agreement last week on the experiments that will be carried on the first British satellite to be launched by National Aeronautics and Space Administration.

Agreement on the verbal U.S.-British satellite project followed a general agreement to cooperate in a scientific satellite program reached last summer. Discussions stemmed from the U.S. offer through COSPAR to furnish launch vehicles for satellite experiments to be relayed by other nations (AW Dec. 14, p. 30).

British agreement was reached on the scientific level, and negotiations between the two governments will be conducted to complete a formal pact. U.S. also has an informal agreement with Canada to launch a "capsule sonar" satellite for ionospheric studies. France, Australia and other nations also are reportedly interested in joint programs.

General outline for these satellites will probably be the solid propellant Scout, which is expected to become operational this year. First British satellite, scheduled to be launched in late 1961, will be equipped to conduct ion and electron studies, to measure electron temperature and concentration and ion mass spectrum, electron density measurements, solar radiation studies and primary cosmic ray measurements.

Organizational arrangements for the joint program also were made last week, and members of the working group and project managers are now being selected.

Generally, the joint U.S.-British program calls for the launching of three British satellites into 300 mi. orbits. The satellites are expected to be 30 in. in diameter, 20 in. long and weigh about 150 lb. Program has been estimated to last four years and to cost about \$1.6 million (AW Sept. 7, p. 27).



BOOBYPLATE Mercury capsule is mated with Little Joe booster during prelaunch check down. Monkey launch was scheduled 12 hr. before launch and post before capsule mating.

Blowout Plugs Fitted to Pershing SCRAM Missile for Range Control

New York—Army's Pershing selective combat range test program (SCRAM) will be fitted with engine blowout plugs to control its flight, Martin Co. officials said last week.

Pershing's initial flight tests are scheduled to start next month (AW Jan. 18 p. 23) at Cape Canaveral, Fla., pending completion checks by Army Ballistic Missile Agency at Huntsville, Ala., according to William S. Bergen, Martin president.

Bergen said the program is on track and added that spending on the missile, estimated at \$108 million for fiscal 1969, is expected to rise to fiscal 1981 to \$146-150 million.

A two-stage, solid propellant missile, the Pershing is designed to hit any predicted target between 10 and 476 mi. When a computer determines that the missile has reached the velocity required to hit a selected target, the plugs in the head of the engine thus operating are blown, thrust of the afterburning engine drops to zero, and the missile begins its on-target. The Pershing is

ways is launched as a two-stage vehicle, even if the second-stage engine isn't required for a close target.

At present, maximum range for the Pershing is believed to be just under 500 mi.

With the 10,000-lb weight limit imposed on the Army missile, Pershing program engineers had to get less weight and more distance by switching from steel to titanium motor casings (AW Oct. 28, p. 12) initial tests with the titanium casings were not as good as had been hoped for, according to Martin. More expensive titanium casings also were sought in a budget squeeze.

Most expensive part of the missile is the guidance system, Bergen said. Guidance system for the Pershing is manufactured by Boeing; the missile's two solid propellant engines are made by Thiokol.

Concerning other Martin projects, Bergen had this to say:

• **Original assignment** due for the Atlas, June, 1961, still is in effect

despite recent failures (AW Jan. 11, p. 58). If the missile starts flying, Bergen said, there will be no air drop stage in the original timetable. A critical plug will come sometime in the next 30 days when the Titan will be tested for mid-flight separation and ignition of the second stage, the only major factor in the contract.

• **High energy reusable propellant** for the Titan is under development at Aerojet-General, propellant contractor for the Titan. Range of the Titan could be extended beyond currently estimated 6,300 stat mi. by bringing the 5-ft diameter second stage out to the 10-ft diameter of first stage. For every additional second of burning time, the missile can pick up an extra 330 mi. of range. Range of the Titan is the same as that of the Atlas, 24,000 ft. Loaded and ready for flight, the Titan weighs at 205,000 lb., compared with the 255,000-lb. initial gross weight of the Atlas. (With a 10-ft diameter second stage, the Titan would also weigh 255,000 lb.) Of the 65,000-lb. deficit, 46,000 lb. is fuel. Nuclear warheads of the Titan, if authorized in weapon, is about double that of the Atlas and eight times that of the Minuteman (Kent) Bennett, of Convair, who was in New York last week to conduct a [testimony of Aerojet-General's] Read Award for his work on the Atlas, took exception to these remarks. The Atlas, said Bennett, will do anything the Titan can or may do, including carrying the same one payload over the same distance.

• **After an months change** in the sub-missile and a cold sink to -65F just prior to launching, an solid propellant Lucerne missile were successfully fired two weeks ago by U. S. Army troops at Fort Chiswell, Cal.

• **Solid propellant Ballpark missile** has made up a 95% reliability record, which is significantly higher than had been anticipated.

• **Martin is trying** to sell its Minuteman probe defense command to use to FAA for use in traffic control. Company is developing many variants of this system. Gen. the Minuteman II, which now is in the prototype stage, handles a smaller number of missiles but is truck-transportable.

• **Norwegian SNAP** (submarine airless nuclear power) project, all based on submersible power, which the company is developing has made Martin one of the largest submersible contractors. This year, for the first time, Martin's nuclear business is in the black.

Although the company is not making any direct contacts between military and commercial business, Bergen said, it does hope to build up the commercial side primarily through its own design work.

Soviet Pacific Rocket Tests Aim At ICBM Operation, Space Re-Entry

Washington—Initial shot in the planned series of Soviet rocket tests in the Pacific apparently was aimed at testing propulsion, guidance and recovery systems associated with intercontinental ballistic missile operation and with the return of space vehicles to earth.

The Soviet Union has increased heavily the potential of its own anti-aircraft ballistic missile for peaceful exploitation of number areas of the globe system, but the range, guidance precision and recovery systems associated with ICBM capability. Successful re-entry techniques and systems are also vital in returning a space vehicle—manned or unmanned—from orbit.

Last stage of the rocket fell in the Pacific target area previously defined by the Russians, and they said it landed within 124 mi. of the target point (AW Jan. 24, p. 36). The powered mid-to-late stage and dummy sub-stage hit a peak speed of 16,175 mph, and the last stage traveled 7,757 mi. from its launching site near the Azal Sea. It hit a peak altitude of 365 mi. during its 36.5-min. flight, according to Soviet sources. Art A. Shermak, who pointed out that the small guidance error involved could result from a velocity error of 0.03%, says simultaneous duration of 16 in. plus seconds in velocity angle.

Then, the Russian news agency, and the next-to-last stage of the rocket re-entered the atmosphere at a height of 90.55 mi. and "disintegrated and partly burned up." The protected nose cone

was ejected safely and impacted near the target where three Soviet ships (see p. 3) registered the impact with radar, optical and acoustic equipment. Ties also and the ships obtained valuable electronic data on final stage of target. The Russians said the rocket was fired from a test area and followed its planned program through all stages of the flight. Prof. Boris Kostomarov reported that radio contact with the vehicle was maintained throughout the flight, including the critical re-entry phase. Further flight tests are planned, and Tass said they will compare in the same area.

The official Soviet report said the re-entry flight test was the first in a series which will provide boosters to put heavier earth satellites into orbit and to power flights to other planets. Missions dreamed by various Soviet sources include larger Sputniks than were previously put into orbit and larger payloads for lunar exploration than the one that photographed the far side of

the moon. Missions to Mars and Venus also were projected, and Academiens S. Sobolev said the first tests will be to set up astronomical observations in space to study the universe. "Observations on Mars and the moon will probably be established as our future," he said.

Possibility of television transmission from the moon to earth was outlined by A. M. Kagarov, and he said that moon telephoto cameras would "be able to make a photograph of the moon from the moon's surface."

For trips to Mars and Venus, Kagarov said it can be demonstrated by simple collection, "that its radio communication with earth guidance of a rocket heading, without any system, it will be necessary to have on earth superpowerful radio transmitters on the order of thousands of kilowatts."

Noting the velocity reached by the powered mid-to-late stage and the dummy final stage of the test vehicle, Soviet scientist U. Dobronovskiy noted that a later version of the rocket will be able to reach space velocity and travel to the next planets when engines are installed in the last stage. He said that after completion of present preliminary tests, a last stage landing on the sea tested will be launched into space for scientific observations.

Dobronovskiy also noted that the last stage nose cone was protected from burning during re-entry and said: "This

is of paramount significance for further work on the creation of artificial earth satellites capable of a return."

Heavy earth satellites could be controlled with a space navigation system, Dobronovskiy said, and such a satellite could also be equipped with a telescope to obtain photographs of planets and stars which would not be disturbed by the earth's atmosphere.

The Russians have been accused of exploring their Pacific tests for political purposes, but they said that the tests in the Far East were quick to land the Soviet test as a Communist victory. Wu Yeh-Hsun, vice president of the Red Chinese Academy of Sciences, declared that the "progressive force of the Soviet scientific revolution is million by, while the progressive force of the non-progressive U. S. Atlas guided missile is only 160,000 ft."

Some hints of a sea broadcast from Moscow that the Russians are experimenting with new methods of launching satellites. Science Weekly told Tass the rocket test was a triumph for Soviet scientists who could now test types of fuel for rockets, and he said the fuel and engines prepared by Soviet scientists had been tested in the Soviet Union. A propellant of all those installed now has at its disposal the space flight.

Vladimir also commented on the "special alloys and other materials" used to protect the rocket's final stage during re-entry, observing that "no man-made body has ever before withstood such enormous air friction as was the one with the ballistic missile falling into the Pacific."

Although D. Kalashnikov, vice president of the International Astronautical Union, and creation of a new space rocket may also be regarded as one of the stages in preparing manned flight into outer space, official Soviet policy continues to assign more space flight a lower priority than earth satellites, space probe and planetary exploration activity.

Russian news items the Pacific has significance beyond even as a test report since since the Soviet Union will send out a probe to land on the moon, returning space vehicles. Writing in Soviet Fleet, N. Vlasov said the world's oceans assume an increasingly important role as advances are made in space travel because they will be used "not only for the landing by parachute of individual stages of vehicles, in order to prevent expensive equipment for several experiments, but also for ensuring automatic landing of flying apparatus," which are returned from space flights.

Yel'tsin said the convenience of dropping spent rocket stages in the ocean, and he said there is no doubt that "eventually the wastes of the ocean could be used for the landing on water of space ships returning to earth."



Blue Steel Bomb Fitted on Avro Vulcan

Blue Steel test off bomb, developed by A. V. Roe Cos., Ltd., is shown coming out of the belly of an Avro Vulcan four jet bomber, the bomb is carried in the bomb bay of the Handley Page Victor jet bomber. Note lower vertical stabilizer which folds for ground clearance. The bomb will be tested at Australia's Woomera Test Range, near the Victoria (AW Jan. 25, p. 38), present tests will the Victor's V-bomb jet bomber.

Mercury Capsule Recovery Plan Detailed

New York—Major National Aeronautics and Space Administration planning effort has gone into the launch phase of the Mercury flight to ensure that recovery of an astronaut can be made quickly if the flight were to abort before an orbit is achieved.

Operational and equipment details on Project Mercury were presented in NASA speeches at the annual meeting of the Institute of the Aeronautical Sciences here.

A string of ships reaching across the Atlantic under this capsule flight path and an elaborate computing system to assist recovery of the capsule automatically are the main elements in the recovery system. An aircraft-launcher pilot will be available 25 sec after the capsule opens its given point, so that if all goes well it will be Union wharf on an aircraft carrier within a maximum of 25 sec after the booster burns out.

If an orbit is established, the capsule is aimed, the flight director officer at the ground control center has the responsibility of deciding within about 50 sec whether to shoot the air-to-surface torpedoes to bring the capsule down at once or to let it continue on toward the coast of Africa.

If the parachutes are fired at once, the capsule will be allowed to drift so that the capsule will come down in the

vicinity of a rescue vessel a few hundred miles north of the Azores. If the flight is continued toward Africa, the ship is to land on a ship off the Cape Verde Islands. A total of 12 ships are spaced from the launch pad at Cape Canaveral to the middle of the Atlantic Ocean under the possible position of the flight.

Other Details

Other details concerning Project Mercury included:

- Special van will be used to ease the pilot in the launch area and keep him comfortable after the last 10 sec before the flight. The van will be equipped with systems to check out his pressure suit and personal instrumentation. A television monitoring system in the van will make it possible for him to observe all phases of the launch.
- "Chemo-pilot" mobile town will be provided to allow the pilot to leave the booster quickly after the launch. The pressure van has been pulled back from the booster and is expected that the pilot will be withdrawn for a considerable period before launch.
- Capsule impact with ground or water will be broken by a cushion of air formed by the fast-burst, rubberized glow-bar sky which connects the heat shield with the rest of the capsule. Heat shield is released from the capsule after

displacement of the main parachute and the bag fills with air. On impact, rush-inning effort is provided in saving air through holes in the skirt and junction of the capsule.

• Ground control over any Mercury flight has been broken into two separate units with a different individual in charge of each. The pilot will have very power over all electronic media during the countdown, launch and recovery phases. An operator director will be in charge of launch readiness, search and other ground operations. A flight director will have responsibility for the flight and will have to make the final decision to abort, on the basis of telescopic instrumentation. Alerts also may be initiated by the pilot and an automatic abort-warning system will be installed on the booster.

• Abort-warning system on the booster is expected to launch the capsule away from the booster a minimum of 12 sec before any explosion or catastrophic failure. The warning system was devised after a study of all accidents on the ground and light data on rocket engine failures. Sensors will monitor altitude, rate of acceleration, engine chamber pressure and possible electrical system failure.

• Safety check will be the most important safeguard device aboard the capsule. It will be based on the ground to fire the retrothrusters for re-entry at the proper time if the planned orbit is achieved. If the planned orbit is missed, the pilot will be connected through radio signals from the ground to coordinate with the actual orbit. The pilot also may use his perspective and a stop watch to roughly calculate his orbit and correct the retro-thrusts. A command signal with the ground will be used.

• Large map display in the ground control center at Cape Canaveral will show the progress of the capsule as it moves through its three proposed orbits and also across the atmosphere and lands on the Atlantic Missile Range. One side view of the map there will be visual display showing the physical condition of the pilot and the performance of his life support system and other vital systems. Detailed monitoring of the various mission systems will be conducted by personnel at consoles which fire the large wall display. The open news director and the flight director's director are in the center of this group so that they may receive detailed information on impact.

• Flight capsule will be checked in a hangar prior to mounting on the Atlas booster. A complete check of all of the systems will be made there to simulate a launching. The capsule then will

be returned to the hangar where a new boost will decide whether it should be used for the flight.

Eighteen technical reports are given during the IAS meeting. These included that:

• Materials development is proceeding at such a rapid pace that aluminum can be the most efficient type of heat protection for virtually all types of high speed vehicles traveling in the atmosphere, according to R. M. Wood and R. J. Fagnano of Douglas Aircraft Co.

• Balloons generally are the most efficient deacceleration and stabilization devices for bodies traveling at high super sonic Mach numbers, which Rayble Robinson and George A. Smith of Lockheed Martin Co. presented.

• Shock waves in the atmosphere are said that they are plentiful in certain speed/altitude lead factor combinations and that thermal strength deterioration is accelerated by, according to John M. Gault of Bell Aircraft and John H. Burns, of Douglas.

• Ultrasonic welding has unusual out-standing and immediate importance for structural design involving thin, high-strength, high-temperature, refractory metals for applications where high structural integrity and low bulk modulus are important in the design of J. By Jones and Harold L. McKing of Aerospacelab, Inc. Ultrasonic welding means when a sonotrode tip is placed against two pieces of metal clamped together with a high temperature heat source. A single face-to-face welding means has been devised to permit the application of the high clamping force without substantial fingerings. Use of many tips to the current. The sonotrode tip ultrasonic oscillating force which combine with the static force of the clamping to introduce dynamic stresses in the metal and produce a ductile deformation which effect a bond between the two pieces of metal. The weld is a polished gradually as the properties of the material are altered in a transient manner.

Speech of 300 to 400 combination metal and fluid system were given by Philip Michael of Sikorsky Aircraft, along with 300-ton-pole metal helicopters in 1970.

Michael, chief of advanced research at Sikorsky, described research results indicating that gas helicopters can be designed to climb at 175 ft/sec with surface propellers at 175 ft/sec 200 ft in the near future.

The means to accomplish this speed increase include increasing negative blade twist to clear blade stall on the retreating blade, increasing rotor solidity



SECRETARY 5-15 with wings hung on one of 20 of the rotor disk axis. Rotors will be in a control system in which the windmill behavior of a wing in the presence of a rotor is controlled. The wing is mounted on a four-blade rotor which maintains the wing lift drag and pitching moments independently of the rotor lift.

In adding rotor blades reduction of parasite drag (not blade loading) and the addition of helicopter or other form of aerodynamic propulsion.

Speech to 300 ft will require all of the above plus the addition of other wings to reduce the load supported by the rotor blades at high speed. Sikorsky is performing flight test experiments with an S-55 fitted with such wings.

News Digest

Biomechanics important to direct reconstruction of Defense Department's medical support of Project Mercury has been named by Maj. Gen. Donald N. Yates. Defense representative for Mercury program operations. It is Gen. George M. Knorr, staff surgeon and chief of the occupational health research laboratory at Fort Monmouth, Lee Center, where Yates commands.

Western Electric has received \$30 million contract for Project Mercury airborne tracking network, consisting of 15 systems, from National Aeronautics and Space Administration.

Jet exchange on transatlantic flights will be shipped Jan. 15 in Pan Am's new World Airways, Trans World Airlines and British Overseas Airways Corp. The equipment for a jet air change has been developed by the International Air Transport Association.

Charles Vought Aircraft, Inc., an aircraft plant, lost track to acquire by Fairchild Systems, Inc., and, indirectly, Fairchild, Inc., in parent now in Skokie, Ill., produces high-speed manufacturing system for use in manufacturing plant machinery.

British Overseas Airways Corp. Director Chairman Sir George Gribble, who is also chairman of BOAC's health and safety committee, has requested for

action according to London reports. He is chairman of Sir David Edgar, chief of BOAC, who has been replaced as chairman of the BOAC, now acting director of the airline, was reported as replacing Gribble as deputy chairman.

Belgian government lost track close the Lockheed T-104C to re-equip its air force. Licensing agreements have yet to be made, according to Lockheed Aircraft Corp.

Republics Aviation Corp., Farmingdale, N. Y., has been studying possible acquisition of Allen B. Dunston Laboratories, Inc., Chino, N. J.

Fifth shot in a series of full-scale model Venerable launches was made last week from Edwards AFB, Calif. Model which simulated the actual size and weight of Venerable, was the first to incorporate the prototype control system and autopilot guidance. Thrust chamber also may have been guided by the autopilot. As in the past, only the first stage was fired and parked. Model.

Air Force-Martin Titan test launch on aborted last week when the first stage engine was automatically shut off immediately after the engine was detected a failure. Jet pump overspeed and the malfunctioning speed control was each reported. Flight was to be the first test of the Titan second stage. Martin probably will launch one Titan this week and may launch a second.

Aerquist-General Corp. has acquired majority interest in certain stock of Electro-Optical Systems, Inc., Pasadena, Calif. New capital will be used to extend company's research capabilities and operations. Emphasis also will be placed on increased development of products more for commercial, industrial and space applications.

IAS Makes Annual Awards

New York—L. J. Jones, deputy assistant of Great Britain's Ministry of Aviation and Elmer A. Sperry, Jr., assistant Sperry Products, Inc., executive were entitled to honorary fellow of the Institute of the Aeronautical Sciences at the 15th annual meeting here last week.

The Institute also presented annual awards for 1970 to the following:

- Dr. James A. Van Allen, head of the Department of Physics and Astronomy at the State University of New York, the second annual Louis W. Eldred Space Transportation Award, for the discovery of space reflection belt.
- Ray G. Dux of D. Philpotts, USAF Air Research and Development Command's Assistant for Research, for the John J. Allen Award, "for outstanding contribution to the advancement of aerospace through medical research."
- Dr. Herbert Riedel, associate professor of astronautics, University of Chicago, the Robert M. Lous Award, for outstanding contributions in technology.
- Kenneth J. Gould, assistant to the vice president for engineering of General Dynamics of General Dynamics Corp., the William Albert Reed Award for his major role in the development of the Minuteman.
- Dr. Joseph E. McGuire, senior scientist of Aeronautical Research Association of Princeton, the Lawrence Sperry Award, for outstanding achievement in the aerospace field.

Named in fellow of the IAS Dr. Joseph V. Chirak, assistant secretary of the U. S. Air Force, Dr. Alfred Eggen, Jr., assistant research scientist at NASA's Ames Research Center, Van Ness John P. Howard, deputy chief of Naval operations (Development), Los Angeles, head, professor of astronautics at the Goddard Space Research Laboratory, California Institute of Technology, Dr. G. C. Lee, professor of mathematics, Massachusetts Institute of Technology, E. J. McGuire, associate director of NASA's Lewis Research Center, Dr. H. J. van der Meer, president of astronautics, Delft Technological University, the Netherlands, L. A. Wood, vice president of Boeing Aerospace Co. and general manager of the AeroSpace Division.

Capital to Offer Stock in Refinance Plan

By L. L. Doty

Washington—Capital Airlines last week announced a refinancing program that includes a proposed offering of 989,699 shares of common stock on the basis of a new share for each old share. A registration statement covering the offering was filed with the Securities and Exchange Commission.

Under the plan, equity capitalization is being broadened to cover 559.2 million of new individual stockholders in connection with the purchase of seven Boeing 880 turboprop and five Lockheed Electra turboprop transports. Lufthansa Brothers and Smith, Barnes & Co. will manage the underwriting. Here is how the new financing will be handled:

- **Current five-year-old** 15% 61¢ installment equipment purchase notes of \$31,161,000 will be refunded to their creditors. The notes originally amounting to approximately \$67 million will be replaced with new notes in connection with the purchase of 80 Vickers turboprop Viscounts.

- **Refunding of the balance of the original note** will be handled through the issuance of three new notes. These include \$12 million 6% secured notes to be issued in bonds. Approximately \$9,665,000 of the cash proceeds of these notes will be applied to the refunding of the original note to bring its balance down to \$25 million. This will be covered in part by the issuance of prior secured promissory notes issued to British manufacturers in the amount of \$17 million which will bear an annual interest rate of 4% with a grace period ending July 1, 1970.

- **Unsecured** 10% promissory notes of \$15 million will be covered by the third series of notes. Five percent secured promissory notes in the amount of \$15 million.

- **Series A Equipment Trust Certificates** totaling \$25 million will be issued to insurance companies and will be secured in a direct mortgage on the company's existing fleet.

- **Series B Equipment Trust Certificates** in the amount of \$25 million will be secured in the same manner as the Series A Certificates.

- **Manufactured Subordinated Notes** (U. S.) \$1 will be issued in the amount of \$10 million to General Dynamics Corp. and in the amount of \$4 million to Lockheed Aircraft Corp. Manufacturers Subordinated Notes are not to be secured by a second lien on the assets of the company, in seven years \$880 million Lockheed Electra subject to both the prior right of the interest in

der the equipment trust agreement and the prior lien securing the \$10 million.

At present, Capital's indebtedness in excess of \$12 million in 4½% convertible subordinated debentures due July 1, 1970. The airline has raised 989,699 shares of the authorized 2.5 million shares of common stock including a reserve of 388,800 shares for conversion of the convertible subordinated debentures.

New stock shares will be offered to subscribers through rights on the basis of one share for each share held. Subscriptions price will be announced when the registration statement is approved.

Total cost of the seven Boeing 880 turboprop aircraft to \$153,333,000. The first of the first aircraft will begin in October. First two Lockheed Electra will be delivered in May and the balance of the order of five will be delivered in June. Total cost of the Electra is \$15 million.

The airline contemplates complete refinancing at its Lockheed 949 in April, 1961, and DC-8 in July, 1961.

The airline's equipment program calls for \$50 million for the purchase of the new equipment and the refunding of the existing debt on the Vickers Viscounts. Meanwhile, the airline has listed seven DC-8s for sale to Pan Am.

Proxmire Opposes Durfee Post

Washington—Civil Aeronautics Board Chairman James R. Durfee was charged last week with violating the Board's code of ethics in making a controversial ruling in favor of Sen. William Proxmire (D-Wis.) in a suit to block Durfee's withdrawal as an associate judge of the U. S. Court of Claims.

In testimony before the Senate Judiciary Committee considering Durfee's nomination, Proxmire asked those three members which, he said, "constitute a serious interest in the fitness" of Durfee for a judgeship.

- **First-day** ruling parties in October, 1960, before the Senate N. C., by Sen. L. C. Burdick, R., vice president of the Flying Tiger Line at the time and now retired chairman of Overseas National Airways.

In addition to Durfee himself and guests including Maj. Gen. Albert F. Wilkins, at the time director of operations for the Military Air Transport Service, James T. Foy, president of Pan American Airways, Robert Proxmire, president of Flying Tiger, George Thompson, president of Trans World Airlines, and in the audience, a number of CAB, Burdick said he and

the World Airways to be used as crash sites as the airline's recently awarded Federal route. Part of these awards was scheduled for delivery later.

Monthly rental of the DC-8s is \$14,700 per month, and the lease runs through to Aug. 31, 1961. The airline hopes to obtain an additional lease on aircraft to purchase the fleet at a cost of \$600,000 per airplane less credit for one-half the aerial fuel paid.

Capital is estimating an operating profit of \$180,000 for 1959 as compared with an operating profit of \$1,015,189 the previous year. The sharp drop attributed to the impact of the turboprop and turboprop equipment introduced by competing carriers throughout the year in major markets served by Capital.

The airline also attributes the decline in operating profit to the effect the steel strike had on custom markets and to a rising cost level which, the airline said, cannot be absorbed effectively because of the lack of steel capacity expansion during the year.

Meanwhile, in a move to offset some sharp drops in traffic, Capital last week filed a tariff with the Civil Aeronautics Board calling for a 25% reduction in fares for a 25% reduction in traffic for the airline's routes to New York between July 7 and Sept. 1.

Proxmire split the cost, estimated at \$85 a person. Proxmire charged that Durfee's withdrawal was a "discredit and neglect" of CAB's role in aviation legislation, and that CAB's role in aviation legislation was being undermined by the Board.

- **Third-day** ruling parties in February, 1961, before the Senate N. C., by Sen. L. C. Burdick, R., vice president of the Flying Tiger Line at the time and now retired chairman of Overseas National Airways.

In addition to Durfee himself and guests including Maj. Gen. Albert F. Wilkins, at the time director of operations for the Military Air Transport Service, James T. Foy, president of Pan American Airways, Robert Proxmire, president of Flying Tiger, George Thompson, president of Trans World Airlines, and in the audience, a number of CAB, Burdick said he and

the World Airways to be used as crash sites as the airline's recently awarded Federal route. Part of these awards was scheduled for delivery later.



United's First Boeing 720 Makes Maiden Flight

United Air Lines Boeing 720, first of the new medium range jet transports to fly in airline service, makes its maiden flight from the manufacturer's Renton, Wash., plant. United has ordered 16 of the 720s, which carry from 90 to 150 passengers (JAW Nov. 4, p. 17). American Airlines has ordered 25, and Irish International Airlines (three). Powerplants are Pratt & Whitney JT3C turboprop engines. The 720s will be powered by JT3D turbojet engines. United will take first deliveries in April.

South Pacific Honolulu-Tahiti Run Scheduled for April With 1049

Washington—South Pacific Air Lines last week announced plans to begin flights between Honolulu and Tahiti April 2 but will hold formal service to one-way schedules because of limited hotel space and tourist facilities on the island.

Following before the Civil Aeronautics Board is the Trans-Pacific Service Case, Walter Sternberg, former National Airlines vice president, and the flight will be operated with a Lockheed 1049 Constellation but added that the carrier had plans to use a new Constellation for the purchase of a 600 turboprop transport for delivery in 1962. Sternberg was recently elected a director of the company, named a member of the executive committee and granted an option to buy 10% of the airline's outstanding stock, which, he said, "I expect to exercise."

In its case, South Pacific is seeking a renewal of its present Honolulu-Tahiti route certificate, which it has not previously accomplished, and is asking for its

extension of that certificate from Tahiti to Honolulu, Hawaii, to Los Angeles and San Francisco and Los Angeles to San Francisco which will serve Tahiti. It also wants nonstop authorization between Tahiti and Los Angeles/San Francisco.

Sternberg and official flight will be made to Honolulu, 1950 mi. from Tahiti, where passengers will connect with Interisland Service (A. 1) which operates Consolidated Airlines (CA) flying buses between Bora Bora and Tahiti. A full airport cannot accommodate the Constellation aircraft but the first 7,000 ft. of a new runway being constructed on the hard coral base of the island's shore is expected to be completed this fall to permit direct service to Tahiti (JAW News 9, p. 50).

South Pacific originally planned to conduct operations on the Honolulu-Tahiti route with a Lockheed Electra turboprop transport but, according to Sternberg, the company found the Lockheed 1049 so that it could begin scheduled flights this spring. He admitted that announced plans by the French airline, TAI, to introduce Douglas DC-8 turboprop service on the Tahiti-Los Angeles route prompted South Pacific to drop the Electra program and to replace it with the Constellation.

In his testimony, Sternberg said the airline will have no problems in generating traffic, which will be accomplished through route package arrangements developed by U. S. travel agents. He said, however, that the company was faced with the major problem of

building costs within the island of the screening potential which the lack of tourist facilities on the island creates. He added:

"We have to get our costs within the area of 75¢ a month (approximately) and approximately \$75,000 per month in expenses in such a manner as to keep our cost-per-passenger lower within reasonable limits."

Sternberg emphasized that traffic increases in Tahiti have entirely upon the future pace of hotel development on the island. He admitted that hotel accommodations are inadequate in number and "to some extent in quality to handle a volume of tourist traffic." He added that hotel rooms and other tourist facilities may not be entirely adequate for the fall year of 1962 but hoped that the introduction of South Pacific and TAI service this year will accelerate construction now commenced and encourage new projects.

American's Earnings Rise to New High

American Airlines earned \$778 million in revenues for 1959, a 19% increase over the previous year and the highest total in the company's history. According to preliminary year-end figures, American's revenue per passenger mile total was \$1.14 billion last year, a 15% increase. Air freight ton sales rose 18% and mail carriage increased 11%.

Public response to jet operations, line increases in 1958 and 1959, and the general U. S. economic upturn were cited as major factors in the record revenue year. W. J. Hogan, executive vice president,

MD-4 to Havana

Moscow—Cuban government has purchased "several" MD-4 single-engine jet planes from the Soviet Union, according to Tass news agency reports. A MD-4 also is scheduled to arrive in Havana within the next hours to "serve citizens" at the USSR's Embassy of Scientific, Technical and Cultural Attachments which will open only this month.

Northeast Keys Future Success to Jets

By Glenn Curcio

Rome, Mass.—Northeast Airlines believes it can survive the competition in markets it entered three years ago and turn a money-losing operation into a profitable one.

Turnover from a relatively small New England base to a participant in the tug-of-war fight for Florida, Washington, and Philadelphia traffic has not been easy, but the airline feels it has demonstrated its competitive capability over those routes, particularly the high density northeastern segment.

Traffic has grown steadily. "Northeast claims its loaded aircraft are properly matched the biggest in trunk airline history. Last year, the carrier's average passenger totaled 1,335,282, a rise of 18.4% to 18,495. Revenue per passenger mile rose 24.1% to 18.57¢. Increases of the same magnitude were experienced in 1974 over the 1973 totals. Passenger load factor last year was 80.8%, up from 47.5% in 1973.

But Northeast's net loss in 1974 after depreciation was \$3,649,417 and before depreciation the 1973 loss will be considerable. For the first three quarters of 1975, Northeast's net loss before taxes was \$3,321,141. The final quarter of 1975 was seasonally favorable to Northeast, but the airline's Eastern route loss was not. Eastern's net loss was out of the Florida competition for most of December.

Favorable Developments

Northeast President James Austin told executives that the airline will call the industry's "one new product" the carrier's operations to offer a good competitive chance in the new markets. Among the favorable developments cited by Austin:

- **Identification in new markets** partly the cumulative effect of absorbing Northeast flight Vickers Viscount equipment in 1975 and put the first units of a 38 plane Viscount fleet into high density routes in the fall of that year. With high level fare, turbo-prop services a selling point, Northeast has steadily increased its penetration of the markets. According to Austin, Northeast now handles more than half the Boston-Washington traffic, has increased its share of the New York-Washington business from 2% to 10%, and has grown in the New York-Boston market from about an 8% share to 35% of the business, with 19 round trips a day.

- **New management team** Among the new officials are returning the airline as Thomas L. Chase, vice president operations, and Edmund O. Schneider, vice president technical affairs. Both

joined Northeast in early 1973. David A. Strick, president of Northeast's chief outside office, the Delta Corp., became chairman of the airline's board in February. Austin said Strick "plans a new reformed part in the affairs of the Northeast."

- **Performance** Schedule dependability has been increased and operating performance now is good, Austin said. Operating factor in 1974 was 90.27%, up 1.29% from the previous year. This includes the short-haul points in the New England route pattern, where the operating factor has been about 75% over 1973.

- **Prospects for consolidation** of some of the New England services. The airlines will like to combine certain short-haul points, saving several at a time from aspects that can handle faster aircraft. Austin and Marshall are in "growing a sympathetic understanding" among the New England communities and believes the traffic would be economic to better services that could be provided by such consolidation.

- **Jets** Northeast now operates a daily Boeing 707-320 round trip between New York and Florida with leased Texas World Airlines equipment (AW Jan. 18, p. 34). The pretty good of the aircraft, Austin and Marshall are in "growing a sympathetic understanding" among the New England communities and believes the traffic would be economic to better services that could be provided by such consolidation.

- **Jet fleet** To meet its expansion needs, Northeast has opened new ticket offices and terminal facilities and is constructing a 52.5 million hangar and office building at Boston.

No Mergers

"The airline is not considering a merger," Austin said, but in considering a second acquisition that can become profitable. Further inlets is not wanted, he said. Northeast went off already in 1974. It entered the new markets and added five and several dozen 54 million in sales for a period of 1974 to cover losses on the profitable New England routes. The airline is not now receiving outside bids.

Northeast sees the Viscounts for the high density segments, in fast class configurations, and serves Florida with Douglas DC-6Bs in two-classroom coach layouts. In addition to the 10 Viscounts and 10 DC-6Bs, the airline owns 11

DC-10s which handle many of its New England flights. Fleet before the major expansion program 12 DC-10s and 20 Viscounts.

Load factors for 1974, on the basis of 11 months' actual figures plus an estimate for December, were 72.3% for the DC-10s and 55.5% for the Viscounts. However, the Viscount figure includes early months of Viscount operation to Florida, a service which has been discontinued and which resulted in relatively low load factors for that equipment. On the high frequency route, Viscount load factor was better than 80%.

The DC-6Bs operating first class also saw the Northeast provide a load factor of about 75%. Florida night coach DC-6Bs averaged about 51% and Florida day coach DC-6Bs about 49%.

Load factor with the leased jets has been 90% in both directions since Jan. 1, the airline said.

Market Penetration

Making Northeast appear to new cities the use of Philadelphia and Washington has been difficult, according to Nelson & Fry, vice president sales. But first Viscount services in 1975 provided the usual "handicapped" and the carrier's management, the market. Fry and the Northeast is dominant in the Boston-Washington market now and has gained substantially in other markets, including Montreal. Schedule increases are planned for next high density segment.

Fry is sold on the Viscount as the best airplane for high density, high frequency commuter type business and believes it will be good for an additional time for the carrier. However, he said, he would like to have more Viscounts, but "jet-cow" first.

Flyer, the Northeast official, said, in a jet market and Northeast is looking forward to getting into it as soon as possible, as strong as possible with its own jet equipment. If this is accomplished, some DC-6Bs will be withdrawn from the Florida area but actual capacity will be maintained by the jets. The DC-6Bs, to the extent possible, would be used on New England routes to replace DC-10s and the rest would be sold.

Losses on the short-haul New England routes can be reduced by consolidation, Fry believes, but these routes probably will not be profitable. However, expansion is expected and the routes can be run close to self-supporting.

With losses cut on the short-haul routes, the airline could start making

money on its long-haul services and break into the black. This depends on the jets, Fry said.

Fry estimated a 10,125 traffic increase in 1968 to Northeast. Among the airline's main competitors in the Northeast, Chase Corp. plan which the airline started last Jan. 1, and the 180-ton Carle Aircraft, for which a traffic has been filed for Feb. 4 reorganization.

On the technical side of Northeast's affairs, functions are being reorganized to make it more efficient. A major change was centralization of aircraft seating, dispatch, maintenance scheduling, control, crew control and communications under a single command at Islip, Long Island, New York. Another change was centralizing engineering responsibility at various, under station managers, instead of splitting the responsibility as had been previously done, with, for example, pilot apportioning to various departments and maintenance workers to the maintenance unit.

In his technical services division, Schneider has instituted a log book monitoring system so that construction in individual departments and individual aircraft can be carefully followed and reviewed.

A "top-down" line has been instituted to keep constant watch on the most troublesome items and concentrate on clearing them.

With schedule dependability a prime goal, fleet utilization was reduced somewhat in favor of reliability. Viscount delays for mechanical reasons rose 4.1% of scheduled departures last April, as frequency increased. The figure for April 1975 was 1.9% but fell to 1.3% last October and has stabilized around that point. Delays have been any period of time beyond the one-half-hour schedule.

Departures Increase

Northeast's worldwide departures per month have increased from 3,239 last January to 7,760 last August.

Engine overhaul periods of the Rolls-Royce Dart Viscount engines stood at 1,700 hr. last April. At year's end, the time was 2,100 hr. and 2,100 hr. is expected to be reached shortly. Time between overhauls of the piston engines also has been increased.

Two-bedded jet-cow planes include the setting up of a subcommittee-supervisory department in the new future.

Northeast's crew training program has been expanded, according to Grace. Improvements include a new basic course for crew for the aircraft. In the ground school staff, soon to include the services of a consultant from Harvard, Grace said Federal Aviation Agency disqualification procedures (AW Oct. 27, 1974, p. 34) have been com-

pletely covered by improvements and FAA recently recommended the airline on its program.

The TWA jets are flown by Northeast crews, part of which have been trained by TWA and part by TWA. TWA handled the training at its Kansas City center.

Questions now lie in making a cost study, Grace said, to determine whether Northeast will firm up on having its own jet crew center. The program itself, TWA could handle the jet training.

Pilots Seek Injunction to Block FAA-Imposed Retirement Ruling

Washington-Air Line Pilots Association and Federal District Court last week to block Federal Aviation Agency's new regulation requiring airline pilots to retire at the DC-8, but the court is going out on May 15 is scheduled.

Earlier, Eastern Air Lines was forced to obtain a temporary restraining order against its pilots, who refused to take flight training on the DC-8. Eastern is the only airline to delay the airline's management of jet service last week. The airline also emphasized that pilot objections to training are concerned solely with the amount of flight captain training pilots can receive under its existing agreement, and they have no bearing on actual pilot training on the DC-8.

ALPA's court action against the retirement rule came a long flight against FAA can sue the rule and follow a union lawsuit to fight the new regulation in the court and in Congress (AW Dec. 15, p. 47).

FAA has until Feb. 2 to answer ALPA's motion for an injunction on the retirement age rule and was given 60 days to answer the union's specific objections.

Regarding the former objections that FAA has the authority to formulate or enforce the age limitation regulation, ALPA said that the U.S. District Court in the District of New York. • **Forced FAA from making the regulation effective** Jan. 15, or any other date.

• **Forced FAA from compelling or requiring any airline to dismiss any pilot on the basis of age.**

• **Forced FAA from encouraging or advising carriers to discharge any pilot on the basis of age.**

• **Rule the regulation is null and void on grounds that FAA is not exceeding its authority in enforcing the age limitation rule to retire without their legal rights to an individual hearing on his career qualifications.**

Malcolm A. MacIntyre, Eastern president, and the company announced its restraining order from the Federal

District Court in Miami, Fla., "in so far as it may be an order" under the terms between pilots and management had to be heard on training to be in the DC-8, but the court is going out on May 15 is scheduled.

The court is scheduled to rule on the week on whether the order should continue in effect pending a settlement of the training question. MacIntyre noted that Eastern was first informed on Dec. 16 of the union position that DC-8 training would not be taken by ALPA, without which a flight captain training program for pilots was instituted. Further negotiations were held, he said, and Eastern made further offers toward expediting training to fight the new regulation in the court and in Congress. He said that the airline's management of jet service last week, the airline also emphasized that pilot objections to training are concerned solely with the amount of flight captain training pilots can receive under its existing agreement, and they have no bearing on actual pilot training on the DC-8.

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BOAC-Ghana Airways Pact Being Revised

London-Edinburgh-Ghana Airways Corp. spokesmen described as "preliminary" reports from Ghana that the Ghana government is to take over BOAC's 48% stakeholding in Ghana Airways.

But he confirmed that negotiations were under way to secure the current agreement.

A statement widely reported in London quotes K. Eboah, Ghana minister of transport and communications, as saying that the airline's 48% stakeholding is being discussed as the first step in incorporation and expansion of the Ghana national airline.

He and the Ghana government would become a full shareholder, but services of BOAC would be retained as a management agreement loan.

AIRLINE OBSERVER

►International Air Transport Assn. is in a move to avoid an open-air fare situation on several routes, formally announced its decision last week to hold a special meeting of its traffic conference. The decision, first reported by *Aviation Week* (AW Jan. 31, p. 49), calls for a Paris meeting of Feb. 23. IATA Director General Sir Willem Bilderdijk, in a letter to member airlines, said the meeting was called because "views expressed to us by many members" now motivated the special "transport" meeting of the conference. Bilderdijk in a memorandum to Bilderdijk (AW Oct. 14, p. 38) felt a large portion of the global fare structure constituted, after functioning as open one-trip fares after Apr. 1 when current fare standards expire. Bilderdijk had said that each fare be recalculated for 90 to 100 days to allow sufficient time to resolve the fare crisis.

►Federal Aviation Admin. has proposed a ruling that would require all foreign flag carriers operating in U.S. routes to equip turbojet aircraft with operating radio transponders. Turbojet aircraft operated by U.S. airlines are now equipped with such transponders.

►Civil Aeronautics Board has approved the lease of 140 Pratt & Whitney JT4C-7 turbojet engines by American Airlines from American, a wholly-owned subsidiary of United Aircraft Corp., for use on 25 Boeing 720-823 medium-range transports on order by the carrier. In the event American should choose to substitute the Boeing 720 for the 720-823, it reserves the right to sell other JT4C-7 turbojet engines for the turbojets. Established value of each turbojet has been set at \$156,237. Turbojet value has been established at \$296,827. As rental, American will pay the established value in 28 quarterly installments at an interest rate of 4½% on the unpaid balance. When established value has been paid, quarterly rent will amount to 1.25% of that value. The airline also holds an option to buy the engines.

►Boeing Airer's Pratt & Whitney JT4 turbojet engines fitted to its Boeing 707-320 transports are expected to undergo modifications at about their third overhaul to increase the thrust rating from 15,900 lb. to 17,900 lb.

►Southwest Aircoast Corp., which will handle JT4 engines for Boeing, will install a JT4 overhaul collection engine furnished by Pratt & Whitney Aircraft Division of United Aircraft Corp. in its test cell facility next to its main shop. Southwest Aircoast Corp. is in test cell facility next to its main shop. Southwest Aircoast Corp. is in test cell facility next to its main shop.

►Lake Central Airlines has signed a contract with the Allison Division of General Motors Corp. for the purchase of five General 145 turboprop engines powered by Allison 505-D15 turbojet engines at a cost of \$8.5 million. Delivery of the first of the engines is scheduled for late summer. Option to purchase an additional 10 of the converted aircraft was granted the carrier by Allison. Flights will operate with a 52-seat configuration.

►Red China's civil airline network is scheduled to be expanded next month to link Chengdu in southwestern Sichuan province with Lanzhou in Gansu province. Lanzhou, a major communications center in western Chinese industrial development, is terminus of the Trans-Siberian Railroad serving airlines in western Siberia and Soviet Central Asia. The city also is a starting point for truck routes supplying Chinese armies in Tibet.

►British Overseas Airways Corp. has announced a major passenger transportation—largely based on travel to the U.S.—designed to extend the use of its ticket refundable plan. The plan calls for a 1979 discount on tickets, about \$47, with monthly payments covering periods of up to 24 months.

►Netherlands has long sought negotiations with the U.S. on revision of the bilateral air transport agreement between the two countries after a series of two weeks. KLM, Royal Dutch Airlines, which operates regular flights from Los Angeles for a planned West Coast-pole service operated with DC-8 turbojets. Prospects for the Dutch winning the new route are dim since State Department officials find the U.S. was "overly generous" in 1957 when landing rights were granted at New York, Miami and Houston to serve for U.S. authority to serve Amsterdam.

SHORTLINES

►Allegiant Airlines will increase nonstop flights between Philadelphia and Pittsburgh this week from 7 to 11 daily. Carvered Conquest 740 turbojet transports will be used on 10 of the scheduled.

►Austrian Airlines has signed a contract for six Vickers Viscount 517 aircraft—making a total of 415 Viscounts sold. Four Viscounts are to be delivered by April 1.

►British Ministry of Aviation reports a 19% increase in United Kingdom airline traffic in 1959 over the preceding year. Ministry estimates show that last year's last miles performed on scheduled and charter services totaled 104 million as compared with 341 million in 1958. Capacity short 300 miles operated in 1959 rose to 147, from 570 million in 1958 to 655 million. Over all last factor on British airlines in 1959 rose 61.5%, up from the 1958 load factor of 59%.

►British Overseas Airways Corp. is expanding its cargo sales department in the U.S. in an effort to fill the expected increase in cargo capacity with the delivery of the carrier's fleet of Boeing 707 turbojet transports.

►Frederick B. Ayer & Associates has leased a Douglas DC-6 aircraft in a 50-greater air coach configuration to Market Airlines. Market also has an option to lease two more DC-6s in the same Civil Aeronautics Board grants the airline additional routes to Orlando, Fla., and Miami, Fla. Market is based in South Florida, Nassau, Bahamas.

►Lufthansa German Airlines plans to inaugurate its Boeing 707-410 service in March with daily flights from New York to Frankfurt. In May, the German airline will offer twice a week 707 flights from Chicago and San Francisco to Frankfurt, with the latter being the polar route.

►Military Air Transport Service is scheduled to open bids from U.S. airlines are invited today for long-term contracts for overseas transportation of approximately 15,000 Department of Defense passengers and 3,000 tons of military cargo beginning in March and continuing through June. The airlines carrier also reports that 31 civilian airlines received contracts totaling more than 574 million for movement of U.S. armed forces personnel and cargo between July 1, 1959, and September, 1960.



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DRAMATIC ANSWER TO THE AIR CARGO DILEMMA

Many air carriers, striving to answer perplexing questions presented by a growing air cargo industry, are facing a basic dilemma: should they convert outmoded piston-engine passenger equipment and put it on to air cargo routes? Should they order proposed cargo jets with 100,000 lb. payload? Should they wait for further turbo-fan evaluation before making their air cargo plane commitment?

Canada's Forty Four, offers a simple, practical answer to these vital questions. It is an optimum-size, all-new, all-cargo turbo-prop airplane that in terms of productivity, is easily superior to converted piston engine equipment, and one that offers, in comparison with the big jets, a payload capacity that is not uneconomically high for profitable operation during the 1960's. Furthermore, the Forty Four suffers little or no operating penalties due to runway limitations, and there will be no community noise problems.

The Canada's Forty Four has a productivity two to three times that of converted piston aircraft, at the same cost per airplane mile, and has a profit potential that will quickly recover any losses on disposal of piston engine aircraft now being used or contemplated for cargo usage. On the other hand, the Forty Four with a payload capacity of 65,000 lbs. and low break-even point is ideally matched to the natural expansion of the cargo market and will begin immediately to operate at profitable load factors.

The Canada's Forty Four is flying now and is in production for the three largest all-cargo carriers in the United States, and

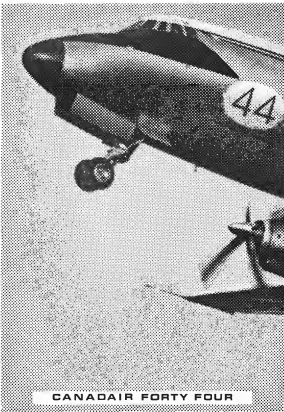
can be introduced into existing fleets as early as January 1961.

The Canada's Forty Four can operate in and out of all airports presently used by four engine piston-powered aircraft. For example, at such an important airport as Midway, in Chicago, with only 6400' runways, the Forty Four can take off with 90% of its maximum payload and fly non-stop to San Francisco. Sophisticated design features, including power tail and integral cargo handling equipment, direct and indirect costs. Step-by-step savings and economies inherent in the Canada's Forty Four, combined with its very attractive price, all promises capital dollars work for better return quicker than other "proposed" equipment.

That General Dynamics Corporation's Canadian subsidiary, Canada, the specialist in air cargo, possesses the Forty Four as the answer to air cargo's biggest dilemma.

Principal Features of the Canada's Forty Four

1. Low prime cost—less than 1/3 the price of proposed jets.
2. Low operating costs—estimated at \$1.30 per aircraft mile, and less than 1/4¢ per ton-mile.
3. Right size for the 1960's—its present payload capacity is ideally matched to forecasted requirements.
4. No community noise problems—confirmed during present flight testing.
5. No airport or runway limitations—every major airport open to the Canada's Forty Four.
6. Growth potential—able to grow with the market.
7. Available for delivery in January 1961.



CANADAIR FORTY FOUR

CANADAIR LIMITED, HOYTOWN, CANADIAN SUBSIDIARY OF
GENERAL DYNAMICS CORPORATION



ONE TYPE of VTOL test aircraft now under consideration is shown above in an artist's conception. Three lift fans of the type now under development by General Electric would be used during takeoff and landing. Wing could be used for cruise.

USAF Plans Operational Mach 2 VTOL

By J. S. Betz, Jr.

Washington—Development plan for an operational supersonic VTOL fighter probably will be completed and put into effect by Air Force for the Tachyon Air Command before July 1, with industry proposals due for submission within the next few weeks.

Priority requests behind the one-seat program affect several years of study, discussion and false starts in the VTOL/STOL field in a block of Defense Department funds offered to the Air Force for use in fiscal 1968 and reversed solely for the development of an operational VTOL weapon system. Necessity of obligating the funds for an operational system before the end of the fiscal year or losing it rules out further attempts to tack on "top-down" configurations through additional requests.

Air Force and industry officials believe that this hasty recognition of Tachyon Air Command requirements offered by the new VTOL fighter program may mean that one of the premier needs of the Air Force during the next decade will be met. This Air Force need, the ability to dispose of manned aircraft and reduce their vulnerability, by circumventing the requirement for large prepared airfields but had a relatively low budget priority in recent years.

While the present VTOL fighter funding support is a step toward meeting such a need, this situation is still less in current weapon system standards. Tentative budgeting over the next six

years includes a total of about \$100 million for the VTOL fighter. This funding level will require a new order of administrative and engineering efficiency and lack of a thorough, tested, operational prototype is to be ready for production before 1967.

If the Air Force succeeds in completing the VTOL fighter development plan before July 1 and in completing the available fiscal 1968 funds, it will be a major management accomplishment, for the entire aircraft development plan in the past has required two to three years to formulate after a requirement was issued. The System Development Requirement for the VTOL fighter was completed last October.

Past Experience

It is felt, however, that the development plan can be completed in another three to four months because of the great amount of VTOL experience gathered in the past by the three military services, government research agencies and universities. One of the major elements pertinent to the development of a supersonic VTOL test aircraft has been done by Bell Aircraft Corp. on the D-188A Mach 2.9 hypersonic VTOL fighter. This project was dropped last year after more than 100,000 engineering man-hours and about \$18 million of military money had been expended to carry it through the research stage. Initial project support came from the Navy in June 1958, and the Air Force entered on a \$2.51 billion approximately six months later. The Navy dropped out

first because of a lack of funds, and the Air Force withdrew its support a few months later after the project had been there for about one year.

Powerplant choice, the same critical area in any VTOL design, apparently will be between the Pratt & Whitney JT12 and the General Electric J85 for the new TAC fighter. These research-developed engines at the 2,000,000 B thrust class have the highest thrust-to-weight ratio of any U.S. turbojet scheduled to become available in the near future. There is a fundamental technical disagreement among soldiers and pilots engineers as to whether such operational VTOL aircraft can be built using these engines. One group contends that an engine thrust-to-weight ratio of 10 to 1 or better is needed if VTOL vehicles are to be successful. The JT12 and J85 have thrust-to-weight ratios of around seven to one, and modern turbojets of higher thrust are well below this figure. The group calling for higher thrust-to-weight ratios, which has adherents in virtually all of the military services and aircraft companies believes that the bulk of the VTOL research and development money should go toward improved engines.

A second group, which has made a representation in the first group, that new engines should be developed, but that these could not be ready for use in seven years. They believe that a supersonic vertical wing fighter with good payload and range can be built with current engines. While the perfor-

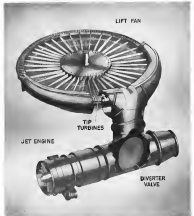
mance of such aircraft may not exactly equal that of conventional designs, the development and operational experience they would provide is considered essential in the design of second generation VTOL vehicles using the new engines.

Current Effort

Current Air Force effort on the new TAC fighter apparently points toward a U.S. high-performance VTOL aircraft in the mid 1960s using present engine technology, but there is no program to provide better jet engines for this configuration. Turboprop research work of the National Advisory Committee for Aeronautics was sharply curtailed after that agency was absorbed into the National Aeronautics and Space Administration. NASA officials believe that the technology is available to ensure the development of dependable turbojets, with thrust-to-weight ratios above 10 to 1 so that the problems involved then arise and it is the province of development people in the services and in industry. Civilian and military engineers do not agree unanimously with this view and many believe that dependable engines in this performance range are years away, with fundamental research as well as development effort still required.

There is more engineering agreement about how supersonic VTOL aircraft should be built. Current Mach 2 fighters have static thrust available at takeoff which is almost equal to their gross weight so that, with little additional development effort, they could take off vertically. Most authorities seem to favor a high-

thrust D-188A Mach 2 VTOL fighter was well into the testing stage before it was dropped last year by the Air Force. Eight General Electric J85 engines were griffled for the aircraft which had a 13,000 lb gross weight.

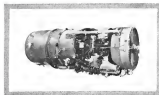


GENERAL ELECTRIC has jet-engine-powered lift fan under development for the Tachyon Prototype aircraft and has been under study for some time. Wind tunnel tests of this device will begin soon at NASA's Ames Research Center.

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Conway by-pass jets for civil use will enter service in 1960 at 17,500 lb guaranteed maximum thrust. The Civil Conway is being developed to powers over 20,000 lb thrust with improved fuel consumption and will power the Vickers VC 10.

The RB.141 family of by-pass jets (20,000 lb. to 17,500 lb thrust) have been designed to give the best possible operating economics for jet transport aircraft. The RB.141 of 14,300 lb thrust will power later versions of the Sud-Aviation Caravelle and the RB.163 of 20,100 lb thrust has been chosen to power the Airbus DH 121.



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avoid hedgehog attacks, but the jet engines added to their exhaust flow is directed toward the ground at an angle versus the exhaust to turn it 90 deg. downward.

The main points of contention surrounding Black 2 VTOL fighters up possibly concern not just their, do with conventional fighters in this speed category. The big aircraft carrying large quantities of armament equipment to provide as all-weather attack capability, not clearly sufficient power performance to the small aircraft if the powerplants are equal. The desire of most air forces to have all-weather reconnaissance and strike capability built into a single aircraft will further favor the large fighter.

For its first VTOL fighter the U. S. Air Force apparently wants a large aircraft of between 30,000 and 50,000 lb gross weight with room for sophisticated all-weather sensors if the handling becomes available. The Royal Air Force is developing a smaller transport VTOL, the Hawker P.1127 which is due to fly within the next few months.

German Work

Planners of the West German Luftwaffe believe that a heavy Mach 2 light VTOL fighter approaching 50,000 lb is an absolute necessity if it is to play a useful part in any future war. The Luftwaffe expects that all of its proposed aircraft will be destroyed during the opening phase of any war because of their close proximity to the enemy. It must, therefore, dispense its striking and defensive force.

For this reason the Luftwaffe believes must have relatively long range, an all-weather capability and a mission time around time of more than two hours to be effective. Messerschmitt and Heinkel are collaborating on this design. The Germans are believed to be conducting development of an engine design to meet the aircraft's performance they want. Conqueror work with Rolls-Royce also is in progress looking toward the possible use of variants of the RB.145 or RB.163 engines.

The supersonic cruising VTOL transport is a somewhat different problem than the fighter. The thrust required at cruise for this very large aircraft is much lower than its takeoff weight so that it needs most power at takeoff than it does during its other flight conditions. Several avenues have been advanced for this problem of engine usage, but the one that seems to have found the most approval in Europe and the U. S. would have a tandem of engines that would be operated only during takeoff and landing to provide lift while others would provide VTOL lift and thrust during cruise. At first glance this seems to be a sensible weight penalty, but studies at Rolls-Royce,



K-14, built for GECF by Bell Aircraft Corp., has made successful civil duty recently, transferring into forward flight and landing vertically (AW, June 23, 1958, p. 17)

NASA and Bell Aircraft indicate that supersonic jet transports requiring 800,000 lb. or more using some lift engines and some lift-thrust engines will be competitive with those landing in the conventional manner.

Large weight savings on any VTOL aircraft are realized by using the wing for cruise conditions rather than landing and through the reduced loads on the landing gear. On large aircraft the weight saved will approximately equal the weight of the lifting engines. Use of engines for lift only also may give advantages on VTOL fighters if their gross weight goes much above 30,000 lb. as do their wing area and supersonic speeds it compensates for.

Design of specialized takeoff lifting engines is receiving close attention by most of the world's engine manufacturers. These powerplants are generally believed to be the first that will have a thrust-to-weight ratio approaching 15 to 1.

Principal basis for believing that the thrust-to-weight ratio of lifting engines can be much better than lift-thrust engines rests on two points:

- **Lifting engines** will have only one design consideration—providing high lift at static conditions. No compromise in air flow capacity, component design, etc., will be necessary to give good performance at cruise speeds.
 - **Low operating time** required of lifting engines means they can be of much lighter construction than lift-thrust powerplants which must run the entire time a VTOL aircraft is in the air.
- Other methods of reducing takeoff

and cruise thrust requirements for VTOL vehicles, including afterburning and rocket assisted takeoff, are also under study by engine manufacturers. One idea that has reached the preliminary stage and has been an experimental is a "lift-fan" arrangement under development for Aerojet General Electric's Flight Propulsion Division. This device consists of a conventional jet engine that powers the aircraft's lifting engine. During takeoff and landing a valve in the jet exhaust diverts the flow through a scroll surrounding a large diameter propeller. The propeller is driven by the jet exhaust gases that power the engine. Lifters attached to the tips of the propeller blades "thrust" the aircraft and scroll use this thrust to be sub-merged into a wing, and performance design work has been done on transport aircraft with four such lifters in the wings.

Afterburner Objections

There are two main objections to afterburning either in the fan section or the main engine exhaust, although this device provides a significant increase in the thrust-to-weight ratio of an engine. The high temperature of the exhaust flow will damage takeoff pylons made of titanium, and it is difficult to use an afterburner during such action as such a flow.

An afterburner has ruled out use of new length takeoff of the VTOL fighter using rocket assist. This procedure would reduce the engine power required at takeoff and allow the aircraft to return to its base and land

velocity at a light gross weight after its mission. The logistical problems of supplying the rocket engines are the main objection against such operations.

Development of hybrid VTOL aircraft, however, and, with it, VTOL, will represent only a small part of the total problem of restoring the vulnerability of the Air Force's ground-to-air warfare. Severe difficulties with maintenance, supply, local security, communications and command will be created if individual aircraft are located near, miles apart in a vacuum of protecting them during an abrupt war.

Boeing of pilots, assignment of targets, navigation in the air, airbase control, etc., probably will require a whole new generation of rapid response communication systems if dispersed units are to remain effective. While dispersed units are aircraft from high speed weapons, it will greatly increase their vulnerability to sabotage, or command tips, attacks by small groups and single soldiers. A double, ground-to-air security force would be necessary to keep the planes from making a few runs and TNT for many millions of dollars worth of aircraft and sophisticated equipment. Maintenance and servicing of dispersed aircraft between missions undoubtedly will require some skilled ground crewmen from air-powered units. Air Force tables of organization, Manpower and checkout equipment will be needed.

The supply function which is difficult enough now, let alone in air groups will be magnified several times in dispersed. Attack aircraft consume about twice their gross weight in fuel

and weapons when flying four or five missions a day.

A 50,000 lb aircraft probably would require 100,000 lb of more of supplies to be brought into its landing area during 24 hr of intense action. An efficient VTOL transport aircraft probably would be essential to such a supply operation. The complex logistical task of keeping fuel and weapons on hand around an atomic battlefield is miles large enough to be useful and small enough to be safe would seem to be one of the most hidden problems of air future war.

It is estimated in many quarters that the operational complexity surrounding VTOL aircraft would run the overall cost of such TAC units up to two to three times higher than the current level. Most Air Force officers believe that this is the price of survival as an effective force, however, and that, if the proper equipment is available, dispersed will present the easier a difficult problem.

Disposal of their combat aircraft is also a primary planning device of the Navy and Army. A complete overhaul of the Navy's current concept also would be possible with VTOL aircraft. Carrier-based ships could be used to carry a few aircraft, and vulnerability of a strike force could be greatly reduced.

Army wants to keep its troops dispersed around an atomic battlefield and use VTOL aircraft to bring them to gather quickly for short periods of combat.

Most of the VTOL research and development work performed in the U.S. during the last 15 years has been ap-



Grumman Affiliate to Build 104-ft. Hydrofoil Craft

Army's operations of its 500-ton hydrofoil craft capable of speeds up to 60-65 kt which will be designed and built by U.S. Marine's subsidiary by Grumman Aircraft's affiliate, Dynamic Development, Inc., under a \$1.5 million contract. Design is the result of studies over the past two years on applications of aerodynamic principles to the hydrofoil. Craft will be 104 ft long with a 210-hp, twin-propeller will be a gas turbine engine. Construction of the aluminum ship will start next month, and launching is scheduled for June, 1968. For photo of Grumman's hydrofoil method, see AW Jan 25, p. 156.



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Mirage 3B Two-Seat Trainer Makes First Flight

Domestically Mirage 3B two-place trainer, which has all-weather interceptor capability, has made its first flight. The French Air Force is expected to order 10 of the trainers. Payload is 6.5 times that of the single-seat version (AW Nov 30, p. 51).

flexible to the design of the VTOL transport that would serve as TAC's supply vehicle and personnel carrier during dispersal. Because of an ultimately short range mission, the aircraft will no doubt be subsonic, and it may prove possible to have it meet the Army's battlefield requirements as well as those of TAC.

An extremely wide variety of research work has been carried through the flight test phase, and an experimental model of virtually every conceivable type of subsonic VTOL has been financed by the military services. Taking wings, lifting rotors, deflected propeller airplanes, dual power aircraft with air-lifted rotors, revolving jet engines, deflected jet exhausts, wingless servomotors, tail-jetted with towed fins, are all have been studied, and most more than once.

A substantial amount of information has been gathered on the performance of these vehicles, and the general confidence of industry and the military in useful VTOL has been established. Many disagreements still exist, however, over the relative merits of these various concepts. Only way that any order can come out of such differences is through the establishment of definite military missions and aircraft requirements.

For example, there is no firm definition of VTOL and STOL. Some people use the VTOL designation should include aircraft that can take off in a distance equal to or less than two times its own length. Many engineers believe that all useful VTOL aircraft should have STOL capability with certain percentages of overload, but that is not a universal opinion.

It is generally agreed among engineers in this field that two definitions are

hampering these requirements and definitions. First is the low priority given to the dispersal problem by all of the services. The consequent low funding level has forced VTOL activity to remain in the research stage. The second problem is that no VTOL funds have been spent on operational evaluation. They have gone toward proving flight qualities, and little or no effort has been made to establish by experiment exactly what difficulties will arise with each type of VTOL when it is operated in the field.

Firm Policy Due

This situation apparently will be altered somewhat in the near future, for the Army intends to establish a firm policy and requirements for its battlefield VTOL-STOL vehicles by Mar. 15 (AW Dec. 14, p. 39). The Army also hopes that it will receive Defense Department agreement on a funding plan covering several years that will allow that equipment become available to study these requirements.

The Air Force will have to follow a similar course if VTOL logistical aircraft, communication vehicles, and all the elements of a weapon system are to be ready for production at the same time as the VTOL fighters now being planned.

Some of the NASA research findings that will affect the determination of specifications for VTOL battlefield transport aircraft emphasize the tail of the military in dividing exactly what vehicles they need to fit their tactical plans. These findings include:

- **Dust and debris** thrown into the air by the downwash from VTOL aircraft will be one of their primary operational and maintenance problems. Downwash dynamic pressure from helicopter

rotors generally runs from 3 to 10 g's, while those of ducted propellers and jet engines range above 200 psi. Dust and sand particles begin to rise at about 2 psi pressure. In a landing on a sandy site, a cloud of dust immediately engulfs a vehicle with downwash dynamic pressures of around 100 psi, cutting off the crew's vision and making it safe to spot from a distance. Good and fields will withstand high downwash velocities for a short time but some sort of rapid landing site reinforcement appears to be necessary if VTOL aircraft are to have good tactical versatility.

• **Operational speed and altitude** will have a greater influence on VTOL configurations than they do on conventional aircraft. If high speeds at take-off level represent the most important mission requirement, a single or even wingless jet appears to offer the best results. Lift coefficients during such a mission is low, so that the wing can be removed to eliminate its parasitic drag and weight. Such a wingless aircraft has the possibility of performing approach better than one with a wing. The situation is reversed, however, if climb performance and good ferry range are required.

• **Ground cushion effect** that has been mentioned upon to improve the performance of some VTOL and ground effect vehicles has not proved to be universally beneficial. On configurations similar to the helicopter, the lift is increased substantially when the rotor is within one-half diameter of the ground. However, if the lifting downwash comes from a flat surface as from a fan in ground installations, large losses in lift can occur near the ground. The jet exhaust from these lifting units tends to flow out along the ground and pump the air

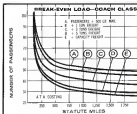


No other jet age airliner—pure jet or jet-prop—can match Vanguard's economy of operation. Seat-mile costs can be under 1¢ on all stages over 1,000 miles, and only 1.5 cents at 500 miles.

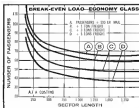
"Passenger only" break-even loads are 41 feet class or 68 coach class on a 250-mile sector, and as low as 46 and 52 passengers respectively at 1,000 miles. This is without freight revenue. With 3 tons of freight, only 55 coach passengers are needed to break even at 250 miles, and 40 at 1,000 miles. Vanguard's below-deck cargo holds enable the aircraft to be a profit-maker on off-peak services and in off-peak seasons.

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Vanguard's low operating costs and large, well-balanced payload capacity of 29,000 pounds mean the highest profit potential in airline history!



This graph illustrates the Vanguard's considerable operating economy when freight is carried. The economic flexibility of the aircraft is indicated by its freight load capacity. For example, seat costs drop to 1¢ on 41 passengers on a 250-mile stage and 20¢ on 1,000 miles.



The "Economy" class record and low per-mile costs of the 120-seat Vanguard are shown in these curves which give the break-even points on all routes. United cargo rates are 1¢ per lb. of freight on a long-haul stage. Freight revenue is taken at 2¢ per lb. of freight in short-haul stages. Freight revenue is taken at 2¢ per lb. of freight on a 250-mile stage and 20¢ on 1,000 miles.

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NASA Initiates Study On Impact of Space

Washington-Breadings Institution has received a \$100,000 contract to explore the long-term social, technological, economic and political impact of space exploration for the National Aeronautics and Space Administration. The Breadings study was initiated by the NASA Committee on Long-Range Studies, which is responsible for studying potential benefits, opportunities and problems involved in using advanced and space activities for peaceful and scientific purposes.

The study, which will require a year to complete, will be directed by James M. McLeod, director of the Breadings Conference. Program on Public Affairs and former executive director of the

National Science Foundation. The study will attempt to share NASA's own work of research, experimental studies and methods, suggest research priorities and indicate potential uses for the results.

Other contracts awarded by NASA in November include:

- **Smithsonian Astrophysical Observatory**, \$200,000. Design and build ultraviolet space wave, instruments which are to be tested in sounding rocket flights.

- **Boeing of St. Louis**, (Contract Dcpt. L-510,000). Two die tables plotting electron densities at various altitudes, using data from a number of space experiments.

- **U.S. Weather Bureau** (Contract Dcpt. L-510,000). Installation of five temporary receiving stations to record telemetry from Explorer VIII launched Oct. 13, 1959. These stations are in

the Pacific, one in the Atlantic and one in Maine.

- **Massachusetts Institute of Technology**, \$50,000. Study contract to develop a proposed advanced development program for navigational equipment suitable for use in circumlunar and planetary flights.

- **Naval Research Laboratory**, \$50,000. Study thermodynamic properties of sodium at high temperatures for possible application in sodium-electric power generating systems.

- **Navajo Corp.**, \$348,000. Airborne pressure devices for the X-15 research plane. These sensors, to be used in flights out of the earth's atmosphere, will aid the pilot in determining the correct reentry angle.

- **Army Ordnance Corp.**, \$480,000. For purchase of Cluster solid rockets with \$270,000 going for Cluster development in the Little Joe phase of the Mercury program and \$210,000 for Cluster to be used in the second stage of the free-stage Scout landing vehicle.

- **Federal Aviation Agency**, \$160,000. Construction and relocation of VOR (variable omni-range) airplane radio facilities as to avoid interference with a new Mercury landing station to be built in Bermuda.

- **National Research Corp.**, \$110,000. To deliver ultra high vacuum system and prototype of an externally low pressure detector to measure atmospheric pressure at high altitudes with sounding rockets.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for \$25,000 and over as released by the Air Materiel Command.

Boards Production Division, Dayton Aircraft Corp. Dayton, Ohio 100-445 on service assemblies for 10700 main wheel assemblies across 11-1114, 101 on main wheel assemblies (Ident. Type VII, Approx. 41,240) and data on instructions for 21,400 aircraft. (PRs 100-4-1010-5434 and amendment No. 1) \$145,000.

Boards Production Division, Dayton Aircraft Corp. Dayton, Ohio 100-445 on service assemblies for 10700 main wheel assemblies across 11-1114, 101 on main wheel assemblies (Ident. Type VII, Approx. 41,240) and data on instructions for 21,400 aircraft. (PRs 100-4-1010-5434 and amendment No. 1) \$145,000.

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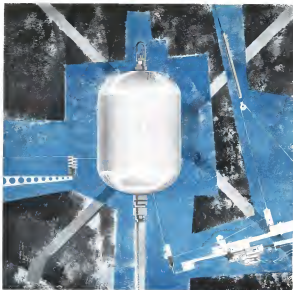
Soob J35A Production Line at Linkoping

Sweden's Saab 350A double-deck jet engine (AVI 77, p. 90) production line at Linkoping is shown above. New version, the J35R, powered by Rolls-Royce RB 148 turbojet with afterburner, entered March 2 as trials, will soon enter production.

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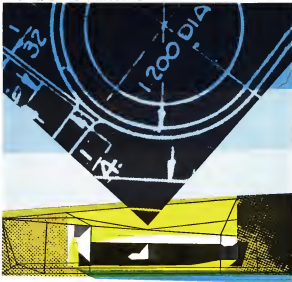
matic control of tension to glass ratio gives Brunswick outstanding uniformity of material composition. From complete in-house design and fabrication to final testing, Brunswick is ready to serve you. Find out more about SBP. Get detailed and documented information on its many usage features. Write or call: Defense Products Division Sales Manager, 1700 Messler Street, Muskegon, Michigan—today!

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SPACE TECHNOLOGY

Vivid Hallucinations Plague Test Subjects

By Emina J. Balban

San Antonio, Tex.—Seven problems of human hallucinations were experienced by operators of space weapon systems and their flight training probably will have to encompass as possible such phenomena, Dr. George T. Hasty, professor of experimental psychology at USAF Aerospace Medical Center, Brooks AFB, admitted here.

Experiences by test subjects exposed to simulated space flight environments for 10 hr at the School of Aviation Medicine's oceanic sealed chamber are a point of belief that they were seeing govtals, experiencing coloration changes that control panel instruments were melting and dropping off the panel or that the cabin's television monitor was burning.

Single Task

Tests at the school, on both sea pilot and experienced jet-pilot subjects, required highly restricted subjects to monitor a weak perceptual field for a prolonged time period, to study effects of an unperceived action in instrument whereby normal input of sensor events are severely reduced by forcing the subject to concentrate on a single task, to the exclusion of other activities.

As the tests progressed, researchers monitoring the subjects were alerted to note that the chamber occupants acted in progressively bizarre fashion as subject sensory events waned up the entire sensory spectrum, as well as to which they were committed to develop hallucinations of increasingly severe character, Hasty reported.

For example, the report of one subject in his own words, after the test, is as follows:

"The instrument panel placed in front of me, various colors which were subsequently withdrawn after a brief period. Colors such as red, orange, brown, blue, and black-green lines throughout, pink, black, dark blue were perceived at one time or another. These colors would appear to represent the complementary color of the black color of the instrument panel. At approximately 1:30 a.m., my vision appeared to be a very bluish color. It was my impression that they had been installed with an idea as a recent loss. After the experience this bluish color was also perceived toward a navy blue tint. It was not recognized as my own because of the latter shade."

Not only did the subject not recognize his own color after the experience, Hasty reported, but denied it was his and would not take it home.

Another subject reported: "Toward the end of the 10-hr period I seemed to be in a relatively good stage, reasonably alert, so I was striving with the test as well as to increase my own confidence in my ability to maintain a high level of efficiency. Suddenly the instrument panel began to melt, very slowly at first, progressively faster within a few seconds or minutes, until finally the instrument panel was actually melting and dropping on the floor. That induced a surprising degree of panic because I was trying to increase my proficiency while having to cope with indications which I could not read because they were melting, dropping on the floor or burning."

A third subject reported:

"At 11 a.m., I began to slow down and experienced a rather frightening illusion. The walls about me appeared to be dipping down to a normal, bottom level 1 ft below the instrument panel and I was falling into this pit. Several seconds later, all was normal."

As Hasty pointed out, the results of the experiments are extremely interesting because in manned space operations, an astronaut is not only to be exposed to an unperceived action environment, but in an advanced weapon system he

will be required to maintain displays for prolonged periods.

The sixth test procedure in the tests utilized four jet-pilot subjects who were required to look back at the highly accurate and nature of the human experiences they might encounter. These "flights" were followed by four comparable missions by four experienced jet pilots whose backgrounds included flights of long duration involving no-to-nostrating. The pilots, however, were not given any prior notice or instruction as to what they might experience in the chamber.

All subjects were given instructions and training on the operation and control of the life support system required for simulated simulated space flight, practice with the operator's manual and was briefed on the nature of the flight profile.

Flight Schedule

The flight schedule encompassed two phases: six hours of simulated launch and three hours of simulated flight of 30 hr. Subjects entered the chamber at either 0800 or 2400 hr, sat, with the exception of occasional check-out of instruments and procedures, spent the remainder of the simulated day time sleeping, resting or reading, immediately after simulated launch, ascent was made to a simulated 15,000 ft altitude.

Long-Duration Flight Hallucinations

San Antonio, Tex.—Operational USAF jet flight personnel, particularly those engaged in long duration missions, apparently experience human hallucinations similar to those reported by test subjects who have undergone confinement in a severe space cabin simulator here at the School of Aviation Medicine, according to Dr. George T. Hasty.

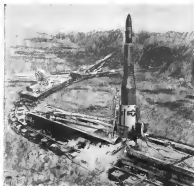
Unfortunately, most exposures encountered in actual flight were unperceived, probably because crew felt that they are in a safe place or are subjected to a vehicle.

A USAF Douglas B-66 jet bomber pilot has experienced a life-like impression that "people suddenly appeared to be walking across the nose of his aircraft" while he was flying over the Atlantic Ocean in the course of a long-distance unaided mission, Hasty said.

In another case, the radio operator on a jet bomber has said that he has seen "ghosts" and other strange little people appear on the face of his radarcope during long missions. A jet fighter pilot whose plane was being refueled in mid-air during a long-distance flight is said to have looked straight into space to complete in the refueling mission, or on the latter that he was seeing nothing, but despite the operator's report that he checked his fuel gauges, which confirm this.

Severe hallucinations are also prevalent among persons having other extensive long duration jobs, such as long-haul truck-truck drivers, Hasty notes.

A system of providing further similar experiences by utilizing flight personnel, that would protect the individuals concerned, would provide considerable valuable information applicable not only to space warfare research but also to establishing patterns helpful in preventing accidents in recent operations, unaided people on.



USAF Envisions Mobile Minuteman Unit

An Air Force study's conception of a mobile missile team Minuteman ICBM based on a launch from a yellow flat-out, zero-report equipment in other use in the field. Study notes have been developed by AFM Industries and American Machine & Foundry Co. (AW Sept. 14, p. 24) for rapid deployment of intercontinental and submarine-launched missiles. USAF says the shifting of locations decreases vulnerability to attack.

and the operator was connected to the activated missile.

Conditions he was given included performing tests provided by the operator manual for the entire duration of the flight. Remaining inside was extremely difficult. The ground crew would not assist him. At 30-min. intervals, trained by the subject, a insurance report was required. This consisted of verbally reporting chamber temperature, rail temperature, barometer reading and zero emissions which the subject now said and, in fact, was actually encouraged to imitate. Reporting time was 10 min.

With the exception of reports, radio silence was to be maintained in the ground crew. Failures did occur in this latter procedure, but only when actual stressful experiences accelerated resistance.

Visual contact with external air readings was denied the subject and external noise was considered extremely dangerous by observer noise. Speech allowed the subject in the chamber was approximately 10 in. Chamber pressure was maintained at approximately 180 mm. hg, partial pressure of O_2 at 150 mm. hg, temperature below 90° and relative humidity below 65%.

at a surprisingly high level. Hasty said a check at the end of flight transcription showed the following typical excerpts:

"This is SAM (School of Aviation Medicine) color, Terra 10, date is February, 1959, time is 1825 hr. I've evidently reached the most, a little more. I must have paid up on. 7th pass (transcript at 1800 hr. instead of 1830-1 hr. now I give it but I'm not absolutely certain. Things are beginning to get a little bit queerer in here now-1 hr. some changes that aren't there, I'm sure, and I'm beginning to see gasoline on the face of this work panel from here to here. And don't be alarmed if you see me laughing at this now, and then-shut it all out and out."

Later, at midnight, Subject A reported:

"This is Terra 10-space cabin to ground-do you read me? I'm tired. I went through some real flying, zero gravity these while ago. You ought to think in this first, some head for awhile. Do you hear me better now? I was just talking about some hellfire time I was going through. I really experienced something harder to air force."

During the debriefing, Subject A said that he had felt that he had been suspended in space within the chamber as though he had been weightless as a consequence he was familiar with since he had read previously in a subject of actual zero gravity studies. Hasty also indicated reinforcing the fact that Subject A had heard a "click" while he thought he was floating in the chamber and this sound had pinned him because he knew that was the click of a release automatically activating a recording camera. He was happy, because he believed that the recording film would "prove" to the observers that he actually floated.

In addition to reporting gasoline, which he and looked like wooden prop jet heads and did not converse with him Subject A also said that he was concerned the direction of his hands and feet that indicated was an indication of operator skills. At times his hands would appear to him to be as large as the entire console and as a result he had difficulty operating specific controls. From his hand it appeared to have his hands and feet made the operator unable to explore the flight rig in "12 ft deep" hole which had opened up in the chamber floor.

Non-pilot Subject B entered the chamber at 1830 hr. and during the subsequent 15 hr. he was isolated and time passed slowly in a manner similar to that of the other subjects. Hasty noted:

"At 1400, 'accident' began and the operator manual was activated. Six min later the subject reported difficulty

in maintaining good definition in the video picture of the display console of the operator system."

"It's still hard to pick those numbers up. It's not like it was yesterday (the information flight). It's not as clear but that doesn't make much difference, the meter are pretty hard to pick up."

Here, one of the outside observers viewed the television presentation within the cabin through a peephole and judged it to be of normal quality.

At 1530, Subject B's transit report noted "Time is 1530 hr. Relative humidity is 42%—cabin temperature is 51°—body temperature is 98.6," and then volunteered "I don't know if it is my eye or the camera—I can see the lights (cabin) now but I can't see where they are. Can't figure it out. I can see it but I can't make out the letters real good unless I get it (the camera) close to me. I have to get it almost on top of me to make out what the letters are." When asked about his eyes, he reported "They don't hurt but it makes a haze-out of most of the letters—Sherr."

The subject was connected to lean back, close his eyes and rest. He complained, but 10 min. later picked up the microphone to report "I've got to get out of here—this hole is too tight—I can't take it anymore."

"Sherr" was immediately started and when the subject left the chamber he quickly asked for a private talk with one of the scientists. In the recovery room he asked if he could talk to a psychiatrist right away to it. And out of his own good will or not, a meeting with one of the men and that he could handle the matter. How this was put as "concern." The "real reason" for wanting to leave the chamber was that the walls were driving him to him.

Subject C entered the chamber at 1800 hr. and closed for most of the uninvited pilot train. Throughout the first half of the subsequent flight he was in excellent spirits, but at the end of the 23d hour (0415 hr.) the operator system was activated by the observer outside the chamber because the subject suddenly shouted:

"...it's and hot, tell them to pull it out! The TV set's hot as hell. The TV set-it's turning all brown-the one sitting right in front of me-right is getting hot. Better turn it off or a heavy-it's getting hot as hell."

He then then held a blanket in front of his face. The observer outside the chamber quickly unplugged the chamber port to view the TV monitor, and seeing nothing unusual, instructed the subject and attempted to alter the subject's anxiety.

"...I don't see that I want to be in here with it, to be honest with



Shot Put Vehicle Launches Sphere

Shot Put test vehicle launched a 109 lb. inflatable sphere from National Aeronautics and Space Administration's Wallops Island, Va., facility in the second suborbital test of the inflatable mechanism to be used for the orbital Project Echo program. Signal broadcast for 31 min. on 94.9 mc. by Bell Telephone Laboratories at Holmdel, N. J. was received by the Massachusetts Institute of Technology antenna at Rosam 186, Mass. Bell Laboratories will broadcast to Columbia tracking station at Columbia in the recovery during actual flight operations. Launch vehicle boosted the aluminum-coated plastic sphere to a 150 mi. alt. rate, and it traveled east across the Atlantic Ocean about 490 mi. Vehicle used a Thrust Segment in a first step, with two Thrust Segments for solid orbital coast. Second stage was the modified Hercules-Airplane Rocket Laboratory X-240 solid rocket which will be used in the third step on the X-240 launch vehicle.

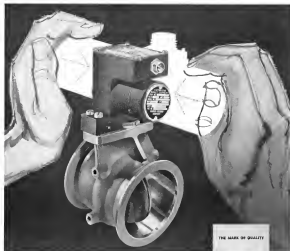
You. That brass pot is still in front of it. It seems to be some as hot as it can be here. I'd pull it out, I really would. Maybe those television you know more about it, but I'd pull it out. I really think the thing to do, if we had another TV set, maybe lower the thing (detected) and get the other TV set, but why don't you go ahead and have that thing off and off the house men. I'd have to know how that thing sits on fire in front of me-it's burning about three-fourths of it is turned brown. The picture is not good either-it would be pretty hard to see anything with it this way. Is there another one down there? Why don't you have

those guys pull that damned thing out. I don't like to sit here being it. Couldn't we get one up first to heat up here? A TV set would do it, wouldn't it? I'd just as soon try it here and finish this three-day run if we could get another TV set. I'd hate to come out now and get another one of these things later on. I'll tell you, I won't shut out to go on with this television situation, I don't believe. I'm pretty skeptical with this thing sitting here in front of me. Is one of the television boys here? What do they say about it?"

The system was deactivated again, Dr. Hasty noted, and the TV system

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can attempted to explain to the subject that the monitor was functioning properly and what the subject thought was happening could not possibly occur, particularly since the monitor "has been modified for high-altitude operation."

However, this explanation did not suffice and the subject was asked if he wanted to abort the flight.

"Later, this is the way I felt about it . . . I volunteered for this thing. I didn't volunteer to sit in front of this thing or tube that turns black in a matter of seconds and goes hot as hell. Now you tell me what I'm doing that I do it, because it is going to do the same damn thing over again, damned if I'm going to sit here in front of that thing. Now to me if we could get hold of another set, I'd like to go on with this fight. But I'm dead set against volunteering to sit in front of that thing. I'd hate to abort the fight as much as anybody, but I'm not about to sit in front of that thing if it is about to explode—I don't know what they do, but if you can't fix it, the same thing is going to happen again. That would just be poor sense."

The subject was asked again if he wanted to continue the flight.

"I'd like to continue the fight but I don't want to sit in front of the tube unless you all can find out what is wrong with it and fix it. I want to go on with the fight, in fact, I want to go on with it cause this anybody because I've spent all this time in here, but I think it would be kind of foolish to do that. I think there's got to be something wrong. If you all can find out what it is, make it won't hurt to come down. Ask the colonel, maybe they can fix this in a hurry."

Later on the subject asked how he could disconnect the monitor, Dr. Harty said:

"Outside observer . . . Anytime you want to turn the set off, just turn the switch and it will turn the power off on the outside—we will turn the set back on for you, and if you get worried, all you have to do is reach up there and turn the set off."

Subject: "Ask these guys one thing. Will these tubes explode?"

Observer: They will not explode . . . I feel that under the circumstances we'd better not turn the set back on. You can just sit back and relax."

Subject: "No, ask these what happens to them. If they don't explode, I'm not too much afraid of fire because there's not too much to burn here, but when I've heard about it, the thing exploding. See, I'm only about a foot away from that thing. It's right in the eye."

Observer: "We're not going to turn this thing on for a while."

Subject: "Okay. What are you go-

ing to do? See if you can find anything wrong out there."

Observer: We've checked and can't find any difficulty—you just go ahead and relax—we're not going to turn this thing on."

The subject waited until 0455, at which time he showed, combed his hair and engaged in other casual activities. At 0555, after having been assured the subject agreed to resume his operation tank and the system was reactivated.

At 0510, the subject was observed chewing gum and working intently—looking through the top of his glasses at the TV monitor. At 0520, he removed his glasses several times—looked around—peered over the top of them. At 0535, he picked up the microphone, and held it as if he was going to talk into it, but made no comment. At 0555, he removed his glasses—stared intently for a few seconds—looked rather wild-eyed. At 0545, subject was looking over the top of his glasses. At 0557, subject spoke into the microphone and turned the detector to look into the periscope—stated that he saw know why the monitor turned known. At 0502 he, subject was told that detector had been started and would continue at a very slow rate until ground level was reached at 1300. He was also told:

Observer: "This is ground. Do you have any further questions? This is the last contact we will make with you. We are going to stop all contact. We are going to get back on our original schedule. Let about silence and know everything is originally set up, okay?"

Subject: "Okay, see. I'll keep working."

Eight minutes later the subject was highly agitated.

Subject: "Hey . . . we are back on the ground, aren't we? I was going to show . . . something before we took this pause off the screen. He probably thinks I'm nuts or something because I called him out here. But no matter, that's what I was trying to figure out what was happening. Look in the back window in the screen, will you? Well, I think what happened is someone was taking the picture . . . something got lost and just among the flames is go up around the pipes, etc., and I thought there was a fire here in the TV screen—it still looks like it—I wanted to show it to you so he wouldn't think I was crazy or something but with that picture on here it's here, and I bet you with that picture off these you can't see a thing on that screen, and I was about hell scared to death I'm that. Okay. Come back here to the screen, I want to show you. It's like sort or something—a barred place—you can see it looking in the back here."

Observer: "Okay, later . . ."

(Continued on p. 13)



Thor Thrust Raised

USAF Douglas Thor, with Redstone re-usable propellant stage, first missile and experimental General Electric X-45A engine, to test during early flight was test flown successfully from Cape Canaveral. Staged dropped off after launch (see cover). Thrust increases. Thor's overall height is approximately eight feet.

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Dornberger Photon of Photon Rocket

San Antonio, Tex.—Photon rocket propellant, considered by some space vehicle technicians as the ultimate goal in rocket propulsion, once discussed in the "chambers of secrecy" by Dr. Walter R. Dornberger, vice president-director of engineering, Bell Aircraft Corp., during a visit to the USAF Aerospace Medical Center at Brooks AFB.

Dr. Dornberger noted that the interest in photon rockets (AW June 16, 1949, p. 28) stems from a high theoretical specific impulse of 10 million sec, but he emphasized, this figure is "purely theoretical" since it is achievable only by complete conversion of mass into energy. The power required to produce a pound of thrust by the photon principle of radiation pressure is 1.3 million kw, or a thousand times that of chemical propulsion devices.

A nuclear reactor could be built to furnish this power, Dr. Dornberger added, with the reactor heating 30 times the thrust of the photon rocket by radiating its own fusion waste products. If the power was to be supplied by solar energy, then a collector of 20 million sq. ft. (one third of a mile in diameter) would be necessary to produce a pound of thrust, he noted.

The photon rocket thus can be discussed as a "spectacularly important idea," Dr. Dornberger continued.

Discussing chemical rocket propellant considerations, he said he believed that with the hydrogen-oxygen propellant combination, the U.S. has reached the limit of specific impulse that can be achieved with any chemical propulsion system.

Subject: "No, no-hey, I'm telling you this scene here is perfect! I agree with you. There's nothing wrong with the scene. It's over there where that's showing it—you've got to look. I'm not looking, you know? I'm not looking here. I'm not looking. I know you that I say. If you'll come to the back window here, it's fuzzy yet—but it is not like that—you could see the best coming up from it."

Observer: "What I want you to do is describe everything—anything you do—for the duration of the flight."

Subject: "Well, look, I'm not going to do any more work. Now look, you're worrying me to death now because I know you probably that I'm looking at something here."

Observer: "We will discuss this when the flight is over."

Subject: "Well, look, come back here because it's here now, no looking. It's got to be. I'll tell you where it is. It's in the center where the little matching diagram are. That's... it wasn't on the screen when I saw it. Then that is better... it's not there... it's just up in the air. Can you see that? That's what I had thought before and I could see the heat waves. You can see the heat waves a little bit now. That's what had us scared to death. I thought it was the screen, the gas in the picture tube, something was wrong with it and I was so sure sleep this morning. I was trying to work the picture and I saw that and it wasn't me. Just nothing is wrong with me, no good, I'm sure. This flight didn't do anything to me. That's the truth. If you come back here you can see it now—the way it was not before, it was even worse than that, but it was the fact. I thought it was going away, but it was the air."

I had it before, but it isn't in the middle part."

After this transmission, the subject ignored the operator's talk. Dr. Dornberger noted. His heart rate, which had ranged from 50 to 55 at the start of the "flight" was now 120. From time to time he attempted to re-establish voice contact.

Subject: "Could I please come down and talk to you again?"

"I've been here for three days—I'm suddenly tired to here. Could I please come down to the ground? I also have to go to the jail and I can't go to here very early."

Severely Depressed

By 0917 hr, voice contact had to be re-established because of the subject's severely depressed state of the subject.

Subject: "Can I come down now?"

Observer: "Well, we've got two boxes to go here, don't you want to finish it up on schedule?"

Subject: "Yes, but if you at some time want to talk about it, I sure want to get that over with because it worries me."

Observer: "Well, at some as you get out, we'll have a cup of coffee and we'll go over that thing and discuss it. Do you feel that you can go ahead in there and complete the work cycle?"

Subject: "I'll tell you. Unless it's important for reports, I feel not necessary to here thinking about it. No looking. I'll just suffer some on out."

Observer: "Well, that is important. Now then, if..."

Subject: "Well, I don't really feel like it—I just don't feel like it."

Observer: "Well, how about then we ignore the work program and you just sit back and close your eyes and relax."



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Saturn Blackhouse Built at Cape Canaveral

Saturn space vehicle knowledge will be controlled from this blackhouse at north end of Air Force Missile Test Center's Cape Canaveral, Fla. launch complex. Saturn complex includes two launching pads with a reusable service tower, and facilities for handling the liquid hydrogen fuel that will power upper stages. The 1.5-million lb. thrust booster, which uses liquid oxygen and hydrogen, was expected to get its first flight test in 1961-1962. Top orbital priority and overhead have been authorized for Saturn (AV No. 25, p. 28).

when we contrast the desert and the mountains of the light."

Subject: "Can I sense out of here? No kidding. I feel incredible here. I just don't sit in here. Really."

Observer: "We'll bring you down a little later. We'll get you out of there as soon as we can."

Subject: "I'd sure appreciate it."

Observer: "All right. Now what I want you to do is—what you do to be very careful about your case. Okay, now here we go."

Observer: "The true air now 10110—1,589 ft altitude. We're about back to ground level. We can see subject is already getting ready to crawl out of the chamber. His heart rate is now up to 150 beats per minute."

The subject emerged wearing a wet, fluid gown and was taken immediately to debriefing. Dr. Harts emphasized several points regarding this experience:

"First to the flight," the subject had been made well aware of the probable occurrence and nature of the abnormal behavior that he might experience. Yet when he did perceive the television monitor "tapping hands," he did not regard this as an illusion, but accepted it as a real event which was unshared by his initial apprehension of his hazard. Further, this "tapping" persisted for two or more hours, perhaps on a highly disturbed state. When it appeared to him that he really wasn't certain what had happened to him and that gradual personnel had some doubt as to his functional integrity, he became even more disturbed and had to be taken out of the chamber.

a real fixed star. I use a wooden rain gauge out of two meters."

By 1930 he, the subject was extremely dazed and would stare for 1-1.40 sec. periods. Upon awakening, he would stay himself to stay awake. Finally, at 1-40, he left asleep for 30 min. He awoke spontaneously and upon seeing the sign on the operator display console, attempted to resume the operator task, but for several minutes his efforts were completely ineffective due to his extreme confusion. Dr. Harts and Ten minutes later, still somewhat confused, he assumed his brand aspect. He also alternated between short periods of prognosis and delirium.

In the debriefing, the subject presented no recollection of having fallen asleep and when asked he had done so frequently, he was asked for an estimate of the time, he had done so and he replied that it could not have been more than several seconds.

Pilot's Illusions

Experiences of the four pilot subjects were similar. Dr. Harts reported, and only two of these noted any significant aspects:

"How about this vertigo you mentioned yesterday. What you explain that?"

Pilot Subject B: "Well, I'm sitting there and I'm about half asleep and I'm trying to fight this sleepiness, and your words were to go this way and you know you're sitting straight and I'm not sure you're looking around. I just had this experience several times like I had vertigo. You'd be up in this attitude or that attitude and you can't look outside this thing and you have to read something, put even an instrument control. I'm not sure if I'm in this attitude or that attitude and then I'm all right."

Pilot Subject C reported: "As I told you before, before after I'd been on the panel for awhile, there were all kinds of things coming out on the instruments. I would make out the shape of different things."

"Such as?"

"Oh your dash instrument. You can see a face or a ball looking at the dial and seeing it. It's the whole thing going together as now and making sure I don't know how to explain it—it's real faint. Also on my radar picture I don't see things there but I lose or presentation every now and then, it's like I'm standing at it now and then I've been in there awhile. The only thing I get is a black and white control rather than having the color presentation of a figure as it comes out, but as I move around the room and look at

from it, I can look back and I have my presentation again, but if I start staring at it, it seems to have a black and white control. It won't be anything particularly. I can lose up to the two controls and make them look like I don't have a figure to work with. It may be work, maybe it's just me being able to stare at things and make them disappear themselves, but I can do it."

"Did this occur during the first part of the test?"

"It's always after I've been in there looking at it a long time before it ever occurs."

"About how long, very roughly?"

"On the last time I don't think it happened until I'd been in there three or four days, but that took me up to the panel. This time I don't think it started happening until that morning on us, it started developing as I'd stare at it and come up with visual shapes and things, but I don't think I got out of it before looking away, with it as other portions of the panel or something and come back to that portion. The lights were beeping on. When the lights were beeping on, I'd stare at the light and there's no submerging with them, but some of these other things, these can be some weird looking change, especially these meters. It always seems like I get a figure out of them right around the middle of the time, for some reason, don't ask me why, it looked like it might be some type of alien or some other thing pointed up around its face and forehead when would be the middle in the middle of the time, and I'd stare at it in real time."

Well, then, from what you say, I judge that this does not bother you particularly."

"No, in fact, the last time I was over here was the first time I had ever happened to me and I guess it's a certain fatigue factor. I don't know what it is. Maybe it's my visual imagination, of which I have one, or maybe I do this unconsciously. Normally when I use a pattern of some type, I try to make something out of it in my own mind. Maybe unconsciously I go ahead and make something out of these, but I make it and it doesn't interfere with my work. It gets irritating at times though. I'm sitting there and looking at it and I thought it would be so much easier and easier if I could forget these things and there and get rid of them and if I can, I can look, move and come back at them and they're clear and then after I'd stare at them while the dunes things would come right back up again."

"Did this persist through the afternoon?"

"Uh-huh, oh yes, it would persist at times from 7:00 after I've been staring at them for a long time. It never happened as an explosion."

Satellite Warning Program Stressed

New York—Development program for certain vital satellite surveillance, warning and communication systems (AW No. 7, p. 279) similar to that for the intercontinental ballistic missile is regarded as essential by Lt. Gen. Ronald A. Schriener, commander of the Air Research and Development Command.

The time to begin this program, he told an American Management Association luncheon last week, is when the technical feasibility of these systems is established beyond a reasonable doubt, and there is a difference of opinion on whether this has been established yet. Schriener pointed out that he did not intend to imply any group or individual was urging an action.

Giving this mission a top priority U.S. military requirements for what seems to be a potentially precarious period the next five years. The other use is for increasing the sustainability of U.S. satellites from other than just one source.

One action he cited specifically in India, a satellite program under development to detect missile firing using infrared sensors. Warning from this kind of action would be very rapid, he pointed out present U.S. communication systems to transmit this warning and set in motion retaliatory forces are not yet quite good enough.

"Adequate and reliable communication between globally dispersed land, sea and air forces is possible—through space vehicles," he said. "This will permit us to exploit our warning to the fullest, even if the time is only 15-30 sec. in length."

Discoverer Re-Entries

Two of the six Discoverer satellite ships fired into successful orbits in 1959 under programmatic control in the case of the first, but the second, and the other two, but the last one for a successful orbit, he said.

Discoverer VIII, launched Nov. 26, is expected to be the last of the Russian C-119 type, although recovery is in the Pacific, but has been seen for a successful orbit, he said.

The Soviets have a much easier task in getting satellites, intelligence about the U.S. than this country does in maintaining the Iron Curtain, he said. Reducing that intelligence inequality has almost value, he said, and space vehicles in the form of surveillance or observation satellites have great potential toward the objects.

He stressed the importance of cooperation in such development programs to avoid excessive long lead times and consequent staff obsolescence. The first cardinal concept of management is an option which were met in the U.S. ballistic missile program call for the following:

- Close and vertical decision-making channels on overall program and policy matters
- High priority to obtain adequate funds
- Complete responsibility and authority for program direction at the operating management level
- Highly motivated and competent personnel



Nose Cone Automatically Points at Sun

New York—When automatically pointed at the sun to obtain extra precise solar measurements has been developed for Air Research and Development Command by Bell Brothers Company, Inc., Bedford, Mass. A nose cone is shown above in 59-day, snap lock and erect. Dents have been used to a 90 in. altitude attached to an Aerospace II research rocket.

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Lag Criticized in Space Biology Program

San Antonio, Tex.—Lacking a central, coordinated space biology program, the U. S. is delaying its national talent to such extent that the future holds little more hope for real success than the past, according to Col John E. Pickering, medical research director of USAF School of Aviation Medicine, Aerospace Medical Center, Brooks AFB.

Critical analysis of the past two years efforts in gathering data on space biology shows the most discouraging factor is the lack of development of a standard space probing system with non-soluble radiolabels, which Col Pickering feels must supplant the current "pigeon-hole" system. Under this system, various groups of space medicine researchers must vie with dozens of other agencies for the right to place instrumentation or a package in a probe.

Unrelated Data

The data obtained, limited and tied only to the concept and based on comparisons that had to be made in a result, lacks the sophistication of both data gathering and reduction which needed, he believes, and results in a

lost collection of unrelated data which is very difficult to interpret and use. Today, each biomedical "islet" is a little nation and trajectory is difficult from the other one and in the long run is a significant detriment to a unified program.

Col Pickering suggests that one way to overcome these flaws in current work of space research would be to develop an organization similar to the Allotment District which is successfully speeded partial development of nuclear weapons. He feels that a similar singular scientific group is needed in the medical space research area and it holds the same unknown as dual nuclear research in the past two decades.

In the nuclear case, one concept was developed that permitted a degree of standardization of the greater efforts—a source of power with varied applications, such as weapons, heat and propulsion. He emphasized standardization with non-soluble radiolabels, yet sufficiently rigorous in design and in facilities, better, more, and sufficient reproducible data developed to enhance scientific judgment.

In the specific area of radiation effects that will be concentrated in space travel he noted that the last U. S. satellite to carry a Geiger counter for cosmic ray measurements discovered a radiation belt (Van Allen belt) so much more intense than cosmic ray intensities that cosmic rays seemed, with subsequent experiments, showed that this radiation extended from a low, bounded to more than 10,000 mi above the earth's magnetic field contours. In addition, solar flares present an even greater radiation source and the nature and amount of these radiations are still speculative. Pickering said, and they are recognized limitations on material space is, communication and material space travel.

Isolating Radiation

Considerable knowledge is available on the effects of ionizing radiation as it applies to defining accurate penetrable levels of radiation from scale and mouse studies, but the radiation spectrum from space is not yet defined. The effects on laboratory sources of strontium, gamma, X-ray, alpha or beta mean at energy levels well below that prohibited in occurring in the Van Allen belt at the solar flares.

These effects must criteria can be established for these sources for guidelines for future probing, Col Pickering noted, but he questioned the specific effects of, say, proteins, which are known in the Van Allen belt. "God damn it, we are not exposing animals to the effects of proteins, he pointed out. Whether proteins produce antibodies, hormones, shortening of life span and genetic changes—and what is the dose effect on the energy effect—must be answered. Another question is there a selective biological effect significantly different from present ideas concerning the sunspot?

Experiments Needed

We can today define a fairly accurate threshold dose for these effects so far as post radiation mouse protein, but as real experiments that are needed can only be done using soluble space proteins he continued.

If radiat power is to be a source of primary propulsion, motor, heat, and battery, will contribute to the problem of radiation protection, particularly in terms of radiation shield equipment in space, the pure radiation. If communication are found to be more non-soluble, then fusion product delay and activation must be considered from the point of isolation and regulation, he noted.

Control definition of movement per

measurable in terms of body fluids from passive sensors, such as Argon 40 and Argon 39, for example, are required, particularly in case of accidents on the launch site or of destruction of the module in space. Reactor powerplant will have problems, under given power (thermal being) and will have some other industrial vehicles.

Since one of our objectives is to ultimately require manned space vehicles, progression in research can come from animal work on various species of mice, monkeys and man, particularly advanced vehicle results from space aircraft to modernized values of the North American X-15 and Diva-Son configurations.

Foylaid Assignment

If reasonable, perhaps more assigned medical scientists could more readily design equipment of a standardized nature to enhance, reliability, and focus data in the area of reasonable periods. Col Pickering told doctors in "When Col Pickering would like to see vehicles assigned to space biology scientists with the ability of carrying approximately 100 lb, up to the area of the Van Allen belt, for animal studies on effects of ionization.

Manufactured equipment to record brain waves, heart action, skin response blood pressure and the like could be proof tested for experimentation in ground patients. Such successful demonstration, he added, would find applications in other clinical research.

A major step in animal research that remains to be taken is a successful repeatable series and subsequent coverage of the biological specimens. A program has been under way for some time to complete this work phase, but development of laboratory instrumentation into flight hardware of limited weight and volume capable of functioning for extended mission times has been underemphasized in its complexity—finder mechanisms, operation, air conditioning equipment, physiological sensors, electrode implantation, programming or sensors, etc. Also, accurate physical and biological data needed to engineer a safe system has been at the low end of the learning curve. Col Pickering said, resulting in significant post-mortem in the program.

In particular, he was referring to the thermal profile data vital to capsule design in support of life specimens. As presently designed, support a question. Accurate data to support this needed system cannot be over emphasized, he said, since it will be translated to the North American X-15, Gemini F102, B-7, KC-135, X-15 and Mercury flights to monitor man in space, most phase of the great flight program.

Additional "no contamination in

needed in gathering physiological and psychological data. Time extension of the test capabilities since approaching normal limits with the Gemini-series, fighters—some 50,000 sec—and yet even when these limits, much additional data can be recorded and teletransmitted, he believed.

Use of large jet aircraft, such as the KC-135 Stratotanker, in spaceflight laboratories, while limited in the time laboratory, will afford observations not possible in the cramped fighters. The KC-135's large fuselage has afforded the opportunity for medical clinics to be present to personally check reactions, make tests and physiological observations by conventional laboratory methods and standard equipment.

Col Pickering said it is conceivable that traditional and reliable data could be collected, and thousands during a human mission may reveal interesting results.

Although extensive work remains to be done using air vehicles and missiles, Col Pickering feels that the bulk of biomedical research will be done on the ground in laboratories and windtunnels, particularly in development of physiological systems and study of the effects of medication, dehydration, sensory deprivation, weightlessness, habitability, psychological day and night cycling and fatigue.



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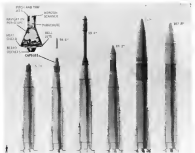


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Atlas-Boosted Space Vehicle Size Comparison

Family of space vehicles that will be boosted by USAF-Corpus Atlas missile shows comparative sizes. Left to right, Altas 2P of the operational RBMs. Next is Mercury, booster. Northward capsule plus escape rocket is 28 ft high. Third is Altas 4B space probe. Fourth is Altas 2000, booster in USAF's Vega vehicle recently winning satellite and Saturn reconnaissance satellite. Fifth is Vega vehicle recently awarded by National Aeronautics and Space Administration which will use Vega Atlas for some Vega probes and Atlas Centaur for others. Last is Centaur as Atlas topped by a Gemini Centaur second stage. Mercury and Altas 4B are NASA vehicles. Centaur will be used for both orbital and missile missions.

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CRYOGENIC GYRO, expected to have drift rates as low as 0.0001 deg. per hour, has been developed by General Electric. The cryo gyro wheel spinning (left) is suspended by magnetic fields produced at near absolute zero temperature, is only one of many promising new devices under investigation in GE's new cryogenic laboratory (right).

Cryogenic Gyro Cuts Random Drift Rate

By Philip J. Klass

Schenectady, N. Y.—Cryogenic gyroscopes, which may provide random drift rates as low as 0.0001 deg. per hour, about drift to 1/10,000 as much as the best conventional gyro now unveiled here by General Electric Co.

To date, General Electric has tested the magnetic suspension bearings and motor of the cryogenic gyro and is the end of the road it expects to have a full engineering model of the gyro in operation.

Initial investigation of the cryogenic gyro principles was made with General Electric funds, but the current hardware program, known as Project Sigma, is sponsored by Army Ballistic Missile Agency.

Because of the size and weight of associated equipment required to maintain the cryogenic gyro at a temperature near absolute zero, the new device is expected to find its initial applications in Polaris submarines and surface vessels. However, with additional development it may find use for guidance of ballistic missiles and space vehicles.

The National Aeronautics and Space

Administration's Jet Propulsion Laboratory also is investigating and developing cryogenic gyroscopes.

A few hundred times more than the GE General Engineering Laboratory, which is developing the cryogenic gyro, another type of zero-motor gyroscope is being developed in the company's Light Military Electronics Department advanced development group. This employs dielectric suspension of the gyro's spinning mass instead of magnetic suspension used in the cryogenic gyro. Monopoles-Haworth also is developing an electrostatic gyroscope.

Electrostatic Gyro

The electrostatic gyro is better suited to operation in a low-gravity force environment, which makes it attractive for use in submarine or space vehicle guidance but less attractive to use in ballistic missile guidance.

The cryogenic gyroscope is only one of many new devices which are being developed from work now going on in General Electric and elsewhere in the relatively new field of cryogenics. General Electric officials predict The company, which began its work in cryo-

genics 10 years ago, has just completed a new \$100,000 low-temperature facility equipped with six constant stations, each capable of maintaining a temperature a few degrees above absolute zero. Some of the possibilities which may result from the application of cryogenics, according to General Electric's Dr. T. A. Buchholdt, who develops the cryogenic gyro, include the following:

- Magnetic flux, which can be used to shape and focus magnetic fields, may operate on electron microscope to view atoms.
- Frictionless bearings, similar to those employed in the cryogenic gyro.
- Motors, which would have no efficiency loss in 100%, enabling them to operate almost indefinitely without continuous application of power to the motor.
- Amplifiers, due to a type, with zero drift and no noise.
- Computer elements, operating the way to extremely small, low-power computer units. Such devices have been under development for several years.
- Resonant cavities, with Q-factors measured in the millions, may permit frequency standard oscillators with ac-

cilities approaching those of atomic clocks.

If materials can be found which can be placed in a superconductive state at higher temperatures (liquid nitrogen instead of liquid helium), it may be feasible to apply cryogenics to special transformers, precision motor windings, the coils of large particle accelerators and to large coils and to energy storage/discharge systems, Dr. Buchholdt said.

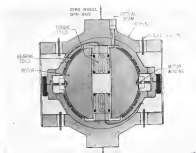
Cryo Gyro Principles

In 1957, Dr. Buchholdt examined the idea of using the principle of cryogenic superconductivity to achieve a magnetic suspension of a spinning gyro wheel, thereby eliminating conventional bearings whose spinous torques cause random drift in a gyro.

Up to a certain strength, a magnetic field will not penetrate a superconductor metal. The reason is that the field causes electrons to flow on the superconductor surface which in turn produces a magnetic field that opposes the magnetic field which produced drift.

If the gyro wheel is made from one of about 10 metals that exhibit superconducting characteristics, and if the wheel is surrounded by suitable heated magnetic fields, it should be possible to suspend the spinning wheel magnetically. Dr. Buchholdt named General Electric's Ordnance Department, a major contractor on the Polaris program, decided to fund the program to determine its feasibility.

To establish feasibility, General Electric made several small motors which were operated as a motor, to characterize possible aerodynamic disturbances, at equal helium temperatures (four degrees above absolute zero) and suspended by magnetic fields produced through superconductors. An additional alternating



CUTAWAY of GE cryogenic gyro shows the bearing coils that produce magnetic fields used to support spinning gyro wheel replacing conventional bearings which cause random gyro drift. Torque coils provide compensation for lack of uniformity in bearing coil fields. Motor winding induces currents in rotor which cause it to spin at high speed.

field, similar to that used in an induction or bistable motor, induced currents in the superconductor which produced magnetic forces that caused it to rotate about its spin axis. One experimental cryogenic motor operated at speeds up to 21,000 rpm for 10 hr without malfunction, General Electric reports.

Although the principle was established, there were many practical design problems which had to be solved before a useful cryogenic gyro could be made. For example, materials were selected because of their relatively high

critical field and superconductivity characteristics, but it is extremely difficult to cut and machine. The solution developed by General Electric consisted of using a hollow titanium sphere with a thin gyro hemisphere of aluminum attached to it.

The main bearing suspension and equipping torque coils had to be fabricated from steel, but the metal was too brittle to make steel rotor heads, and something had to be done to degrade its superconductor qualities. These characteristics also were destroyed when conventional welding or soldering techniques were used on titanium wire.

Plug Thermal Locks

To eliminate the amount of liquid helium required to maintain the cryogenic gyro at its superconducting temperature, General Electric scientists had to plug every possible thermal link. The company developed a thin vacuum type insulator, called "P-Zero," which not only is a better thermal barrier than the previously used Dewar flask but is stronger and more rugged. To prevent the electrical connections to the cryogenic gyro from serving as conductors to cure heat into the superconductor element, General Electric uses transformer action. Electricity for suspension, magnetizing and torque coils is introduced into primary winding, which is outside the thermal barrier. Secondary winding, inside the superconductor volume, is a swirl of aluminum wire.

Inside the bearing is which the gyro wheel spins, General Electric says it

Superconductivity

Although it had long been known that the resistance of metals drops to zero temperature is reduced, resulting zero at a temperature of absolute zero (—459.39 or —273.2C), Dutch physicist Kamerlingh Onnes in 1911 discovered that the resistance of a few metals dropped abruptly to zero a few degrees above absolute zero.

Onnes observed that the temperature at which the resistance dropped to zero (superconductivity) depended not only upon the particular metal being tested but, in part, also depended upon the strength of magnetic field in which the metal was exposed. If the magnetic field strength, either from external source or from internal currents, was sufficiently high, the metal's resistance did not drop abruptly to zero. The point at which superconductivity will not occur is known as the critical field strength.

Scientists immediately recognized that under suitable conditions, an electrical current could be induced in a metal in the superconductivity state which would continue to flow indefinitely without additional application of power.

However, this phenomenon occurred largely a laboratory curiosity without many practical applications until the most recent of efficient helium liquefaction of conductive wire strength.

There are approximately 20 metals, including mercury, lead, tin, cadmium and bismuth, as well as many compounds and alloys, that exhibit superconductivity.

has achieved various levels as high as one microampere per degree Celsius. The company developed special semiconductor cells to permit a tight seal around the cathode without detuning the meter's superconductivity characteristics.

Gyro Operation

The omegagyro gyro is a two-degree-of-freedom device with limited travel. This requires a pair of expanding servo systems in the stabilized platform in which the gyro is mounted to quickly return the gyro axis to its null position relative to the spinning wheel. An optical pickoff

is used to detect displacement of the gyro case (due to vehicle motion) relative to the spinning wheel.

Covers? Electro also is exploring possible use of the device in an extremely sensitive accelerometer. The company also is seeking to develop new materials with higher critical fields. This would permit the use of operating wheels with greater mass and therefore provide higher angular momentum. The company also is seeking new materials which become superconductive at higher temperatures, possible at that of liquid hydrogen or even of liquid nitrogen to ease the cooling problem.

Strain Gage With High Sensitivity Made of Semiconductor Material

Pennsco—A strain gage made of a semiconductor material, which reportedly has 50 times the sensitivity of a conventional wire strain gage, has been developed here by Electro Optical Systems, Inc.

The strain gage consists of a single-crystal whisker or sheet of germanium or silicon which measures 0.001 in. in diameter and 1 to 4 in. long. Despite its small size, the device has a tensile strength of about 1 million psi at room temperature and experiences no plastic deformation below temperatures of 550C, the company reports.

The new semiconductor strain gage is expected to find use in a variety of instrumentation applications where a high level signal is desired with very slight loading on the sensing element.

The device has an ultimate gage factor of 175, compared with a figure of about 24 for a conventional wire strain gage, the company says. Gage factor, a measure of sensitivity, is defined as the ratio of the increment of change

in resistance to total gage resistance divided by the ratio of the increment of change in gage length to its total length.

For applications where a high gage factor/high signal level is desired, silicon diode transistors are used as the signal pickup. However, its high internal impedance, usually many megohms, can result in a noisy signal if long cable runs are necessary to route the signal to its destination. The semiconductor strain gage has a much lower internal impedance which minimizes the induced noise problem. Value can be tailored between approximately 50 and 10,000 ohms to provide impedance match to a telemetry amplifier or an amplifier.

One disadvantage of the new device is the fact that it has a higher temperature coefficient than a conventional wire strain gage; i.e., larger change in resistance per degree of change in temperature. This can be compensated for by using thermistors or by employing

the device in a bridge circuit. When used in a bridge output, there is only a 2% bridge imbalance due to a temperature change of 25C to 100C, according to William Wright, manager of the company's solid state division.

Because of the tiny size of the semiconductor strain gage and its high signal level, it can be employed in sensitive strain applied on an extremely small area, Wright points out. This is important where it is necessary to localize high stress areas.

Piezoelectric Effect

Principle of operation of the new semiconductor strain gage is the piezoelectric effect. This was first reported by scientists at Bell Telephone Laboratories and the Case Institute of Technology several years ago. They noted that when a semiconductor crystal is subjected to tension or compression, it undergoes a charge change in its resistance.

It was Bell Telephone Laboratories which also investigated actual strain under the action and strain of various whiskers which occasionally grow on transparent substrates and cause no detectable modifications. These were found to be single crystals with remarkable tensile strength for their size.

To investigate the piezoelectric properties of semiconductors, Electro Optical Systems materials set out to intentionally grow the tiny whiskers using germanium and silicon. A large sheet of single silicon is placed in one end of a quartz tube which is closed at each end.

The end containing the silicon then is heated to a temperature where it vaporizes and deposits at the cool end of the quartz tube, producing the tiny semiconductor whiskers. Analytical techniques which can be used to slice thin slices from a silicon crystal, then

lap and etch these to the desired dimensions.

The whiskers are extremely strong and flexible and can be bent through 90 deg with a radius of curvature that is only 10 times their diameter without damage or permanent deformation, Wright says.

To fabricate a whisker or direct into a strain gage requires the attachment of electrical leads, an operation that is performed using micro-manipulators.

Initial work at Electro-Optical was limited with computer feeds. About a year ago the Defense Agency's Army Ordnance Corps took over sponsorship to apply the semiconductor strain gage to several specific instrumentation problems where high frequency response and signal level were required. Specific instruments cannot be described.

Electro-Optical Systems, Inc., address is 170 North Dury Ave., Fremont, Calif.



• **Satellite Radar Declines Soon**—National Aeronautics and Space Administration hopes to complete technical evaluation of more than 30 companies bids for a retroreflecting satellite weather radar this month, according to an agency spokesman.

• **Naval Recruiting Twist-Speaks**—Recruiting, whose main plant is located at North Adams, Mass., near the heart of New England's skiing area, is advertising for engineers in a ski magazine. The of fitness a crop which shows Spring's proximity to sport the results.

• **Call for Authors—Prospective authors** who would like to present papers at this year's Western Electronic Convention to be held Aug. 23-26 in Los Angeles, should submit 100-200 word abstracts and complete text on a detailed summary by May 1. Material should be sent to Richard G. Lettner, Western Electronic Office, 1415 South El Comero Blvd., Los Angeles 35, Calif.

• **Automation for Immigration**—An opto-electronic and transputer project must be completed by the end of the year. The project is being led by the chief of the Immigration and Naturalization Service, which is to be completed by the end of the year. The project is being led by the chief of the Immigration and Naturalization Service, which is to be completed by the end of the year.

• **USSR Computer, Transputer Output** to Check-Soviet Union expects to increase its output of computing machines by nearly 400% in the next five years.

Russian production of semiconductor in 1968 is expected to be 20% more than output 10 years ago. No line figures were given for either year. U.S. transistor output has increased by a factor of about 60 since 1954, the first year that Electronic Industries Assoc. began collecting data on semiconductor production.

• **World Inventory Via Electronics**—Air Force will undertake a semiautonomous world-wide inventory of its supply and equipment assets for the first time this month. Electronic data processing equipment and fast communications permit the simultaneous inventory instead of the phased dispatch-class count previously employed.

• **Avionics Get Quick Reaction**—Aeronautical Space Flight Center of the National Aeronautics and Space Administration has awarded a quadrinomial contract to Avion Division of AGC Industries in nearby Alexandria, Va., to provide engineering laboratory and model shop work in printed circuit electronics. New contract is an approved agreement type in which specific projects are assigned as required.

• **Tube Temperature vs. Reliability**—Tests on three semiconductor tube types,

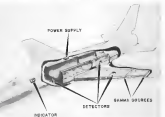
5840, 5802 and 6111, indicate that 2,500 hr of life can be obtained if tube temperature is limited to 160C. Both tubes carried "Electronic Tube Reliability Ratings," identified ETR-151810, is available for \$2.00 from Office of Technical Services, Department of Commerce, Washington 25, D.C.

NEW AVIONIC PRODUCTS

Components & Devices

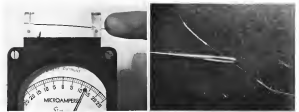


• **Voltage regulator, transistorized**, designed to meet MIL-E-5173 specs and to operate between -55 and +125 C. Output voltages are between .5 and 150 v d.c. at load currents up to 500 ma. Regulation is 0.1% for input



Nuclear Fuel Gage Developed for Aircraft

Nuclear fuel gage, developed by North American's Avionics International, can gamma radiation source, such as Cobalt-60, and scintillation counter to measure amount of liquid in solid fuel in an aircraft. A scintillation counter is used to measure the amount of gamma rays emitted by the fuel. The amount of gamma rays emitted is proportional to the amount of fuel. The amount of fuel is then measured by the scintillation counter. The amount of fuel is then measured by the scintillation counter.



SEMICONDUCTOR strain gage, which gives 50 times the sensitivity of conventional wire strain gage, is attached on cantilever whose very slight deflection produces 11 micrometers output signal level. Stress gage (right) consists of thin whisker of silicon or germanium with leads attached, stress alone is unable to induce strain. Above caption on the principle of the piezoelectric effect.

the world's longest screwdriver

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Now only 1 man—instead of 3—trims fuel controls
of all jet engines... faster... with greater accuracy...
without hazard... all by remote control!

Eliminates exposure to dangerous noise and heat
when trimming at the engine.

LEAR REMOTE CONTROL JET ENGINE FUEL TRIMMER SYSTEM



HOW IT WORKS

In a matter of seconds, a remote-control combination is dropped directly in the fuel control on the engine to be adjusted. This remote adapter is attached to a remote controller located in the cockpit for control of an electrical valve. This remote can make all valve, military power and wing position adjustments.

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110 Iron Ave. N.W.,
Grand Rapids 2, Mich.

variation of $\pm 10\%$ and load variation from zero to full load. Unit measures 11 in. wide, 24 in. deep, and 21 in. high and weighs 15 lb. Powermate Systems, Inc., 50 Flax Court, New Rochelle, N. Y.

• **Video Detector Mounts** provide high angular sensitivities down to 50 mic. Mounts use slow wave structure to create physically short line for matching crystal impedance to input line. Ranges covered are 50 mic to 120 mic, 120 mic to 300 mic and 300 mic to 600 mic. Transducer sensitivities in excess of -55 dbm have been obtained with selected crystals.

Amesbury Electronic Laboratories, Inc., 121 N. Seventh St., Philadelphia 6, Pa.



• **Analog-to-Digital Converter, M4**, performs 12 bit conversion to accuracy of plus or minus 1 millivolt in 65 microseconds over temperature range from -55°C to 70°C . Converter designed to satisfy MIL-E-54000, MIL-S-00577 and MIL-T-19690 (AER). Packaged Bell Computer Corp., 12331 West Olympic Blvd., Los Angeles 64, Calif.

• **High-Q Resonance Filter**, available in small size MIL-T-37A, gives flat attenuation of frequencies down to 20 cps.



Narrow frequency can be spaced to 21 with less than 6 db. loss between notches.

T T Electronics, Inc., P.O. Box 180, Colver City, Calif.

• **Attenuating Current Transformer**, new Series 4 Variostat, with ratio 9



Airborne Thermoplastic Recorder Studied

Developmental thermoplastic recorder (AW, Jan. 15, p. 57) shows at left genuine advantages of softness, contrast, high-density, midband recording process which at this stage of development records with quality indicated by frames underneath paper city (right).

Instruments

• **Strip recorder** provides six independent nonoverlapping and continuous records in next 120 in. wide, 910 in. high and 81 in. deep. Recorder is sensitive



to 1 milliramp full scale, has a second response time, and has chart speeds available from 4 in. per hr. to 24 in. per min. Corbin-Wright Corp., Princeton, N. J.

• **Valve operation analyzer**, Model 1540, is self-contained instrument for functional analysis of solenoid-operated pneumatic control valves and gives mechanically-actuated meter valves. An shunt remotely tests valve sequence operation without disturbing components under test and plots position vs. time graph of valve valve actuator motion. Unit may be programmed for 12 combinations of one hour events in a manual mode and three combinations of one hour in automatic mode and will record and record base events continuously in 1,000 milliseconds with resolution of 10.1 milliseconds. Generalized Avionics Corp., 800 Shuman Dr., Westboro, N. Y.



first and measuring, has 40 to 200 class maximum output impedances, 2.5K to 30K ohm input impedances, line phase shift and dynamic linearity of 99.95%. Polaris Eng'g. Corp., Norwalk, Conn.

• **Power supply**, Model PS4003, provides selectable outputs from 25 to 32 v.d.c. with load current up to 1.5 amp. Unit requires 105 to 175 v.a.c. Ripple and noise level at output is less than



2 mv, regulation maintains output to within 0.2 v. for load changes up to 1.5 amp with line control, and output impedance is less than 0.2 ohm from d.c. to 100 Kc. Power Systems, Inc., Burlington, Mass.

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1000°F.

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Both alloys have high strength without embrittlement from room temperature to 1000°F, plus good ductility at elevated temperatures. They have remarkable stability and excellent corrosion resistance.

AM 350 is available in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355," Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.

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Three Soviet tracking ships have moved into the Central Pacific to monitor long range missile flights (AW Jan. 15, p. 36). Sverdlovsk (above) was photographed from a Navy Lockheed F4V-3. Radio antenna ship (second platform) appears to be Soviet surveillance ship.

Soviet Tracking Ships Operate in Central Pacific

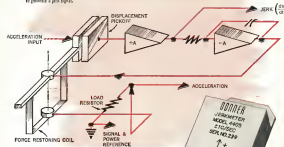


Siber (above) and a sister ship, the Sechen, carry surveillance radar and also appear to be kindred ships for aerial tracking over the bow. All three ships have helicopter platforms near the stern. Navy crew on one flight observed helicopters on two ships.



Sechen (above), USAF tracking vessel shown for comparison, is tied up at Port Canaveral. Russian tracking radio antenna ship, used for sea area patrol and possibly operating at K or K bands, is behind ship at right. Two plastic domes cover optical trackers.

Functional diagram of Donner Linear Jerkmeter. This unique instrument operates as a self-contained non-contact of the force-reference type which is responsive to jerking the sensitivity of the force coil and about the sensitive side of the angular coil. Basically, the system consists of a force-referenced armature with an integrator mounted into the servo loop to provide a jerk signal.



HOW TO MEASURE $\frac{da}{dt}$

New Donner precision Jerkmeters measure linear and angular jerk to $\pm 0.5\%$ or better.

If your measurement and control problem requires accurate measurement of jerk or the rate of change of acceleration, Donner Scientific's new line of precision angular and linear jerkmeters can help. These new instruments are the only truly accurate device of this type ever made. They are designed to meet the most demanding applications. Both angular and linear jerkmeters provide an output voltage proportional to jerk, which in turn can be used to

indicate compressively forced forces or other reasons. An accelerometer analog output voltage is also available.

Typically, a jerkmeter installed in a jet aircraft will provide an instantaneous output proportional to the rate of change of g . This signal can be used to predict impending disaster conditions. Other applications include any whenever constant acceleration is required. Here, the Donner jerkmeter provides a "velocity-damping" sense. The jerkmeter also provides a direct order term for indicating displacement control. It can also be used as an internal indicator of first motion.

KEY SPECIFICATIONS for Model 4405 Linear Jerkmeter	RANGES	Acceleration: ± 1 g full range to ± 20 g full range Jerk: ± 0.5 g/sec full range to ± 30 g/sec full range
	OUTPUT FULL SCALE	Accelerometer: ± 2.5 v dc Jerk: ± 1.5 v dc
	RESOLUTION	0.1% full scale or better
	LINEARITY	0.1% full scale or better

WANT MORE INFORMATION? The new Donner Jerkmeter is a unique product from a firm specializing in the manufacture of accurate force and pressure sensors and is highly diversified in research, design, and custom engineering. Complete technical information can be obtained by visiting your nearest Donner engineering sales representative or writing Dept. 672.



Full size view of Donner Model 4405 Linear Jerkmeter

PRETENSES	Less than 2.1%
POWER	+35 v dc at 10 ma max - 15 v dc at 10 ma
SIZE	3" long, 1 1/4" wide, 1 1/4" high
WEIGHT	7.5 ounces

DONNER SCIENTIFIC COMPANY
CONCORD, CALIFORNIA

BUSINESS FLYING



USBLAGE of two-place, second prototype F-400 Cobra jet engine, second prototype at Milan, Italy, plant of Pavesi, when production of the Cobra will pass that of the Pavesi F-400. The aircraft is a two-seater with a two-place cockpit of 160 ft. thrust.

Italian Cobra Jet Nears Maiden Flight

By David A. Anderson

Milan, Italy—First flight of the F-400 Cobra executive jet aircraft designed by Italian engineer Silvio Pavesi is scheduled for early this year.

The Cobra, a straight-wing airplane powered by a single Turbomeca Marbee 2 turbojet rated at 550 hp thrust, will first fly as a two-seat prototype version. Second prototype and production models will have four places, and will be certified as four-place aircraft.

Pavesi's main design aim has been to combine high performance in the air with short field performance on the ground. Maximum speed of the F-400 is 375 mph at 16,400 ft. Takeoff ground run is less than 1,000 ft.

One major American business and executive aircraft firm has been talking with Ross Neff, director of the Pavesi Corporation, Anversville, S.p.A. (Pavesi) about the Cobra, which is being produced, with a possible goal of becoming production in the United States. Details are sketchy at this stage, and would depend on the Cobra's flight test performance and its ability to meet American airworthiness requirements.

As in Pavesi's Pavesi F-15 (AW Jan 21, p. 94), most of the Cobra is a plywood-aluminum laminate. A thin layer of 99% pure aluminum is bonded on to a thicker plywood base with an

epoxy glue and the combination is used as skin. Thin laminate was chosen by Pavesi to give the airplane increased resistance to weather and corrosion, while keeping the mass input and manufacturing qualities of the wooden structure.

All basic structure is wood or plywood, with metal used in the obvious places. Stainless steel and anodized aluminum are used in the engine bay. First prototype is nearly completed, and at the time of this visit was in the Pavesi factory receiving final outfit.

Second prototype is shown in the accompanying photograph; its basic structure is nearly complete.

Both Neff and Pavesi feel that the performance of the Cobra could be improved considerably with some more thrust, but a major drawback is the cost.

The Marbee engine is an large-scale production by Turbomeca in France, Marborough in England, and Continental in the United States. It is a piston, well tested engine with an excellent record.

Another engine suitable for the Cobra is either too far from full-scale production or too far out on the cost scale. Neff quoted one example where the engine price would have been equal the price of the rest of the completed aircraft.

Design practice of the Pavesi shows throughout the Cobra layout. The wing is basically the same, a simple straight-wing geometry with moderate taper ratio, built on a single spar and in one piece. The wing is bolted to the fuselage with four bolts. Internal wing tanks have a capacity of about 53 gal. (100 liters).

Major change from Pavesi wings has been to bend the air intake into the leading edge and provide for flaps through the root and into the flaps into the ailerons.

Ailerons are hydraulically and sta-

Cobra F-400	
Dimensions and Weights	
Wingspan	28.50 ft
Length	25.95 ft
Height	9.2 ft
Wing area	313.9 sq ft
Empty weight	1,540 lb
Usual load	1,320 lb
Gross weight	2,860 lb
Performance	
Maximum speed, level flight (16,400 ft)	375 mph
Maximum speed, sea level	360 mph
Maximum climb	65.2 mph
Takeoff ground run	965 ft
Landing ground run	625 ft
Service ceiling	16,100 ft
Range at 14,750 ft	521 mi



Solar energy conversion: Through recent advances in materials and electronics, we are on the threshold of a new era of energy utilization. By concentrating solar radiation via the energy of a thermionic converter, electrical power is generated directly from sunlight without moving parts or circulating fluids. This freedom from earthbound energy sources promises far-reaching applications in space exploration. Artur's concept shows the unfolding of a solar collector mirror with its control power package which would be attached to various types of space vehicles. Lockheed design of thermionic converter operating mode is shown at left. The water wheel depicts one of man's earliest known forms of energy conversion.

THERMIONICS

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The development of new techniques in energy conversion is typical of the broad diversification of work at Lockheed Missiles and Space Division. The Division possesses complete capability in more than 40 areas of science and technology — from concept to operation. Its programs provide a fascinating challenge to creative engineers and scientists. They include: celestial mechanics; computer research and development; electromagnetic wave propagation and radiation; electronics; the flight sciences; human engineering; magnetohydrodynamics; mass in space; materials and processes; applied mathematics; operations research and analysis; ionic, nuclear and plasma propulsion and exotic fuels; sensors; space communications; space medicine; space navigation; and space physics.

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LARGEST in the Beech fleet, the Super G18 carries seven persons and can be modified to suit place configurations.

Beech Modifies Twin Super G18 Cockpit

By Herbert J. Coleman

Yutubon, N. J.—Increase in the cockpit area of the Beech Super G18 twin and a larger windshield for better pilot visibility are the major design changes in the 1980 model of Beech's best-selling aircraft.

An example of the G18's continued acceptance after two decades of exist-

ence is this year's production schedule. Of the 190 airplanes to be built, more than 87 have been delivered and 95 more are on a firm order basis, according to Laddie J. Gossert, Beech vice president-sales. This compares with 68 airplanes sold in 1979 (AW Dec 7, p. 46) for \$16.6 million in consumer sales.

Beech has retained the familiar lines of the Model G18 series with the ex-

ception of a long, pointed nose which carries weather surveillance radar; the new nose section considerably increases forward visibility both for towing and in flight, due to a slight downward slope.

Engineers have expanded the cockpit area by 38 sq. ft., a change that is immediately apparent to pilots familiar with the somewhat cramped flight quarters in previous twin Beech models. The windshield (two-piece, separated by a center bar) has been enlarged to give better upward visibility.

In other cockpit modifications, Beech has reduced the trend of the control columns, installed adjustable rudder pedals for the first time and added adjustable pilot and copilot seats. The cockpit is separated from the cabin area by a sliding door.

The cabin noise level has been considerably reduced, in this case through the use of Beech's soundproofing modification and double cabin windows (optional, at a cost of \$1,400).

Largest in the Beech line, the Super G18 has excellent flight characteristics—markedly so at low speeds. The aircraft's gross weight has risen to 9,700 lb., highest in its production history; useful payload is 3,750 lb. Base list price is \$125,000.

Among 31 optional items in the weather surveillance radar. Weather radome to replace the conventional one costs \$1,630. Three radars are offered for factory installation. Beech's



new machines make good students' phonics. Clearly, the remarkable thing about the new Ampex FR 600 is that it doubles the usefulness of every Ampex analog recorder ever built. And it is unquestionably a better machine. But it is compatible with earlier models. It actually lets you do things with them you never could before. Like record the same bandwidth at half the usual speed, 100 Hz at 30 ips, for instance. Twice as many minutes on the same reel of tape therefore. Pretty important in tape's new use at the Ampex AP-200, or mobile use of Model 800's. Even

important in lab simulations using FR-100's or 1100's. Doubled recording time is always useful. Sometimes indispensable. It's possible because bandwidth is determined by the reproduce head. 30 year data will be reproduced on an FR-600, you simply drop the bias current on earlier machines to 5 milliamperes. A 5-minute screwdriver adjustment. Then you record the same bandwidth at half the speed and get twice the recording time. A good reason for getting the full FR 600 story, AMPLEX DATA PRODUCTS CO., 594 Charter St., Redwood City, Calif.



CABIN is shown in four-passenger seating arrangement, with deck space as an option.

This machine doubles the value of every Ampex analog recorder



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... when life or property stand in danger under the shadow of a suddenly earnest missile—the human finger poised over the "Destruct" button moves quickly downward, the information supplied by Cubic Corporation's Bi-COTAB. Beneath the finger of the Range Safety Officer are buttons that will destroy the missile in flight or cut off its fuel supply. The BSO's precise knowledge of trajectory and impact prediction is furnished by a Bi-COTAB, which is the major range

safety equipment for the West Coast's first ballistic-missile base.

From two tracking sites at Vandenberg Air Force Base, like two searchlights with their beams intersecting on the missile, Bi-COTAB derives direction information from standard telemetry signals. At the Instrument Control Center precise measurements and predicted impact points are plotted for the Range Safety Officer... his guide to decision.

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COTAR



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2273 Kearny Villa Road, San Diego 11, California

Beech Super G18

Specifications

Wingspan 40 ft. 5 in.
 Chord 30 ft. 10 in.
 At root 155 in. sq.
 At detachable tip 90.156 sq. ft.
 Wing area 360.7 sq. ft.
 Sweepback at 25% chord 8 1/2 deg.
 Horizontal tail 24 ft. 11 in.
 Vertical tail 6 ft. 9 in.
 Gross weight 5,700 lb.
 Empty weight 4,080 lb.

Performance

Takeoff distance (50 ft. obstacle) 1,800 ft.
 Landing distance (50 ft. obstacle) 1,350 ft.
 Rate of climb (both engines) 1,100 ft./min.
 Rate of climb (single engine) 250 ft./min.
 Service ceiling (both engines) 21,000 ft.
 Service ceiling (single engine) 7,500 ft.
 Maximum speed (60,000 ft.) 236 mph

with a 5 in. scope and 18 in. antenna, S18-500, weighing 135 lb., RCA AVQ 51, 5 in. scope and 12 in. antenna, S12-300, weighing 95 lb., and the RCA AVQ-50 with a 5 in. scope and 18 in. antenna, S17,000 and 95 lb.

The twin's slow flight characteristics have been approved through certification of unheated wing tips and were supplied by Avionics Waco as a short flight in N 766AA, a demonstrator owned by Atlantic Avionics Corp.

For example, in a steep configuration still (half flap and gear extended at 140 mph) the G18 scattered the stall to the point where the aircraft was being slowed to 80 mph and finally was forced into the actual stall. It paid out at about 70 mph with a bank to the left. Pilot's control is fitted with a stick-shaker for stall warning.

Effort of the rudder on top was shown during simulated single-engine operation. The right engine was retarded to idle speed and the left kept at normal cruise power (77 in. and 2,600 rpm).

As speed dropped to 130 mph and directional control was easily maintained in flying the G18 in a slightly right-winged attitude.

Some rudder trim was made but was not vital, the plane can be held steady with rudder pressure. Turn into the idle engine was made with little difficulty and no adverse characteristics were evident.

Powerplants are two Pratt & Whitney B-95 engines which develop 450 hp at 14,000 rpm (2,300 rpm). Propellers are three-bladed, constant speed, full-feathering Hartzels.

For short field performance, the Super G18 can be fitted with Avionics 125S-720 jet assisted takeoff (JATO) units, at an extra cost of \$2,900. The weight penalty is 100 lb.

PRIVATE LINES

New second airport at Alhambra, Tex., has been named Butterfield Trail Airport and is located 3 1/2 mi. north of the city. Jack McCallister is president and H. C. Henderson is vice president. Dean Groves, owner-operator of Gustin Flying Service at Butterfield Airport, has been named airport manager. Airport has a 2,500-ft. paved asphalt north runway and a 3,000-ft. grass runway. Both will be paved this summer.

Reading & Bates, Tulsa, Okla., contract drilling firm, has purchased a Bell

470-1 helicopter for offshore work. Aircraft will be based at Lake Charles, La.

Coastal Advertising Agency, Grand Rapids, Mich., has purchased a Mooney 230 lightplane from Avion Aircraft Co., Vancouver, B.C. Specifications are: wingspan, 38 ft. 6 in.; gross weight, 3,000 lb.; empty weight, 1,510 lb.; maximum cruise, 204 mph; landing speed (with flap), 55 mph; fuel capacity, 82 gal.; powerplant, 180 hp. Continental fuel injection engine.

Alt Tool Co., Tolson, Iowa, has been appointed distributor of Aero Composites for Iran and nearby countries.

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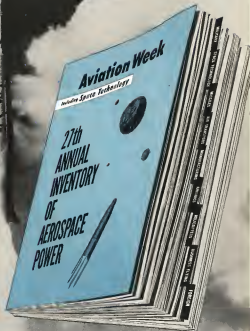
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PUBLISHING DATE: MARCH 7, 1989

SPACE RESERVATIONS CLOSE
February 15, 1989



A REVIEW AND PREVIEW
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EQUIPMENT

Visual Simulator Aids Pilot Training

By Barry Tully

Newark, N. J.—Transition from instrument to visual contact approaches is practiced by Eastern Air Lines pilots with the aid of Dohs visual simulator. Eastern has purchased six Dohs units for crew bases throughout its system and has an option on two additional units. One Dohs unit will be fitted to the airline's DC-7 simulator in Miami. The other visual devices will be installed on Curtiss-Wright DeHavilland light duplicators, the airline's standard instrument trainer.

Visual presentation, in the case of the DC-7 simulator, will be by means of a 9 x 12 ft. projected television image.

The flight duplicator employs a ZMA television monitor placed approximately 3 ft. from the pilot's head.

Aviation Week inspected Eastern's original Dohs unit at the airline's instrument training room at Newark Airport. The equipment had certain broadcast characteristics in that a fabric hood substituted for the integrated nose section needed to accommodate the television screen.

Utilization High

Utilization of the Newark Dohs-equipped duplicator at high Aviation Week's approaches were defined shortly after a new course guided by ILS techniques. The equipment can be set on any runway heading and elevation desired by the instructor. In this manner pilots receive training in their actual route.

The process began had been practicing his approaches to the instrument runway at Washington, Va., and I elected to return this morning. In order to gain the best view of the runway presentation, the weather conditions were set at the Dohs's maximum (300 ft. ceiling and 1 mi. visibility). Power settings and "light" characteristics of the duplicator corresponded to those of the Martin 424. Full instrument approaches were duplicated with the aid of strong traffic. After takeoff and instrument climbout the trainer was placed in the landing configuration and set up by the instructor on localizer heading approaching the glide slope.

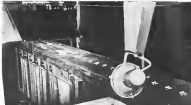
Takeoff in the duplicator was made visually using the Dohs visual attachment. Holding heading on the runway was quite easy and upon rotation of the nose at 105 kt, the runway appeared to fall away and reference to the ay-



PREDICTED television image shows the approach lights of an instrument runway to a pilot practicing instrument approaches with the aid of a Dohs visual attachment.



TELEVISION MONITOR placed 3 ft. in front of the pilot's head provides alternative method of visual presentation. Configuration appears left below, with the runway broad television screen (not shown) to simulate aircraft groundspeed.





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ture, perfectly match exacting jetliner requirements for smooth, safe ground control from touchdown to ramp. Besides being preferred for civilian jets, "Bendix" brakes are first choice on the fastest military jets.

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statements was necessary. On landing approaches the television image automatically presented approach lights and runway. Pitch and roll presentations were making corrections to the runway also were indicated automatically. The duplicate does not have the feel of an aircraft, however, the overall feeling is realistic enough to provide an all-out attempt to get down on the runway. These lifeline and landing approaches were "flowed" with the simulator with varying degrees of success. The duplicate and visual attachment performed perfectly in all instances.

Visual approach simulation of any kind can't teach a pilot to land on a stick. This requires depth perception and a feel of the moving aircraft that cannot be artificially simulated. The visual device does provide practice in transitioning from instrument to visual contact right upon "breakout" from a cloud base and in aligning the aircraft with the approach lights and runway centerline. Additionally, the training device provides practice in developing a sense of timing in regard to the speed at which the runway is approached.

Instrument approaches are heavily new to airline pilots, particularly those flying trips in high density, bad weather areas. The chief value of the Datto and other visual simulator attachments is that it provides increased realism in instrument training and is helpful in checking out pilots in new, better aircraft.

Pilots are taught to determine at the time they cross the decision bar, 1,000 ft from the runway threshold, whether to convert themselves for a landing or to execute missed approach procedures.

Pilots Enthusiastic

Eastern reports that pilot enthusiasm for the visual device is high. Thanks to the development of such devices pilots in instrument trainers would hold landing and descent to field situation at which point they would be rewarded for a successful landing by a sound representing the chirp of new tarmac pavement. Contact with the ground at places other than the runway was signified with flashing lights and visual aids.

The Datto device differs from visual attachments offered by Link and Cessna-Wright in that it simulates only instrument weather conditions and night approaches. The studies Eastern's requirements, on the theory that if you can make the difficult approaches, marginal VFR conditions should offer no problem. Datto says that one feature that is closely integrated with a visual attachment to its simulator is considering adding a Datto device for low visibility night conditions.

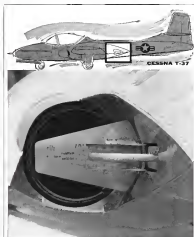
The essential difference between the Datto visual simulator and competitive

devices is the manner in which the forward motion of the aircraft is presented. In the Datto, aircraft forward motion is simulated by means of a moving belt which rolls the runway toward a television camera. The camera is tied in with the light trainer and is free to roll, pitch and yaw while sending horizontal and vertical in response to simulator signals. Other visual devices "fly" the television camera over a stationary airport model in response to simulator signals. This requires that the camera move in three planes in addition to rolling, pitching and yawing about its own axis. One advantage of this system is that it pro-

vides realism in training pilots in an aircraft without encountering a simulated low approach at night for each landing. Another advantage is that a particular aspect may be separated if desired.

The runway, as simulated by the Datto, is painted on a continuous non-precise belt 56 ft. long x 14 ft. wide. The approach and runway lighting is simulated by fluorescent point which is activated by a battery of ultra-violet lights. The belt is servo-driven to correspond to the groundspeed of the aircraft as computed by the simulator.

The camera is free to roll plus or minus 30 deg., pitch plus or minus 75



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Biomedical Engineers... will design electromechanical equipment and electronic portions of guided missiles, including consideration of effort through the ship. Will work closely with Donors Engineers in developing electronic programmer philosophies. Knowledge of electronics, electronic components, and ability to read schematics required. Should have experience in sheet metal equipment design and knowledge of current "state of the art" in electronic equipment.

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deg. and turn plus or minus 40 deg. in heading. Altitude resolution is from -10 ft. to 400 ft., and traverse movement is plus or minus 400 ft. from the runway centerline.

Sequences of flashing strobe approach lights in use on New York's and other instrument runways is accomplished with small area bulbs radiating in the compass belt. The bulbs, lighted consecutively by means of a timing switch, create a visual effect similar to that seen by a pilot even a strobe approach light system.

The main Dulles unit measures 11 ft. long, 5 ft. high and 51 ft. wide. The weight is 1,500 lb., costing a \$600,000 of \$100 per ft. Pair of the Dulles visual attachment is approximately \$70,000 depending upon the visual presentation (projected or cathode tube).

The Dulles Corp. was formed to produce the visual device invented by the president of the company, Ward D. Davis. Originally a part of the Deane Helicopter company, Dulles is now a separate organization with production and sales facilities in New York, N. Y.

PRODUCTION BRIEFING

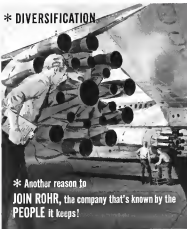
National Aircraft and Missile Fitting Manufacturers Assn. elected William B. Martin, Lewis Engineering Inc., president, and Elton Palmer, Douglas Aviation Associates, vice president. The newly formed manufacturers' group elected the officers at its initial meeting in Los Angeles. The group will coordinate AN and MA's standards through cooperation with military agencies, and engineering associations. The America's office will be located at 53 Park Pl., New York, N. Y.

Bentley Airways estimates a net profit of \$2,502,000 for 1978, compared with \$2,073,799 a year ago, based on un-audited figures. Operating revenues of \$74,715,000 are estimated for 1979, compared with \$60,677,210 the previous year, with operating costs of up approximately \$86,078,000 last year against \$63,266,801 in 1978.

Chicago Helicopter Airways has ordered two more 12-passenger Sikorski S-58s, modifying Avicopter Waco report (Dec 31 p. 50) and bringing its S-58 fleet to eight. The carrier plans to increase its present 137 daily flights to 157 by Mar. 1 and 274 by next fall.

Bushnell air force has ordered 12 Model 47G-2 Trooper helicopters from Bell Helicopter Corp. for use in search, rescue and training missions. Four there were ordered from Fort Worth, Tex., by a Bell Helicopter G-50 transport but now, others will be added this month and next.

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WHO'S WHERE

(Continued from page 17)

Changes

Dr. Theodore F. Hunter, manager of the South, West—Development Laboratory of Minneapolis-Henryville Argonne Co.'s Ordnance Division.

Dr. Robert C. Langford, director of an engineering of the Newark (N. J.) operations of Western Instruments Division of Detronics, Inc., according to Francis X. Lash, new engineering consultant to the new product operations (Newark).

Leslie D. Coffey, director of equipment services, and David V. Kinn, director of engineering, Electronic Division, Shattoung Carbon Division of General Dynamics Corp., Burlington, N. Y.

Alfred Armstrong, chief application engineer for engine products, Marketing Division, the Magnetics Corp.'s Power Systems Group, New York, Calif.

James G. Daugherty, head of the Research and Study Department, Vitec Laboratories, Silver Spring, Md.

Hudon A. Bessett, manager of the Garth Corp.'s Los Angeles, Calif., military systems office.

William R. Richter, chief engineer, Flydution Division, Tetra-Aerodynamics Corp., Los Angeles, Calif.

Spencer Technology Laboratories, Inc., Los Angeles, Calif., has announced the following appointments to Flight Test Operations (North AFM, Fla.): Eugene W. Thibault, associate lead Area Project Officer, William R. McElhenny, associate lead Test Project Officer.

Robert F. Knight, manager of marketing, Northrup, a division of Northrup Corp., Hawthorne, Calif.

W. W. Boston, corporate sales director, Aerojet-General Corp., Azusa, Calif. Fred S. Miller succeeds Mr. Boston as manager of the Solid Rocket Plant sales division.

John H. Gurnea, director of organization planning, Vitec, Inc., Detroit, Mich.

Ronald B. Green, manager of the new aircraft business planning operations, Geo. Al Electric Co., Computer Division, Phoenix, Ariz. Dr. Robert R. Johnson succeeds Mr. Green as manager of engineering.

Alvin Dr. Howard M. Susskind, manager of the new launch application section of American Coach Injury Research, a division of the Pilot Sales, Pasadena, Florida.

Victor E. Kofke, resident manager of American Coach Injury Research, a division of the Pilot Sales, Pasadena, Florida.

Ralph S. White, general manager, Electronic Systems Development Corp., Van Nuys, Calif., a subsidiary of Santa Barbara Co.

Lloyd R. Evansington, director of Research Development, a Santa Barbara Laboratory, and responsible for the operations of the company's most advanced research, Santa Barbara Co., Pasadena, Calif.

Anna R. Egan, chief of the new engineering and Special Research Division of Aerojet Laboratories, Inc., Azusa, Calif.

Col. Augustus M. Preston, Jr. (USAF), manager of market development, Westinghouse Electric Corp.'s Air Arms Division, Baltimore, Md.

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Enemy Threat

From the Anonymous Engineer's column of *Jet* Feb-Mar (SW Jan 4, p. 95), I learned that the Soviet Union and cohesive studies of the enemy threat and the defense forces necessary to cope with that threat tell my country whether or not it is safe. Such "intelligence" are needed, rather than a calculation as an adding machine manipulated by Mr. Stone who must be looking a full six months ahead.

President Eisenhower, who thrust Stone's doctrine, must be reminded that defense and modern war are not symmetrical. It's a good thing Anonymous Engineer didn't have the guts to sign his name, a person with such guts might sign it off as a naive (educational) person, since complete peace in our time forces us to meet much needed arms, which cost more than our strength here, while the armed forces are trying to protect him with such quality weapons.

John S. Yates
Scottsdale, Wash.

Defense Emphasis

After reading about the readiness of the modernized F-105 fighter bombers (SW Dec. 28, p. 77), it is obvious that the Defense Department should only spend less than \$100 a U.S. S&C ICBM can deliver a Soviet S&C ICBM and vice versa, but it takes hundreds of medium bombers and lighter bombers to deliver the conventional forces of Red China and the USSR (in part) to exceed our conventional forces by a ratio of 5 to 1.

It is surprising to note that prior to the Korean War the Truman Administration concentrated on production of the B-36 in terms of nuclear bombers and neglected production of medium bombers and lighter bombers. As a result of this emphasis on nuclear missile readiness in the late 1940s, the Korean conflict induced concern to start the Korean War. The Truman Administration responded by establishing a military program that produced second tiered fighter interceptors and fighter bombers and over 3,000 B-47 bombers. It was the Truman Administration's B-47 program that gave U.S. S&C most of its longer strength during the Eisenhower Administration.

The Korean War that B-47 bombers could deliver Russian bombers and cities with one nuclear missile. The Korean War also knew that 90 to 95% of the B-47 bombers could reach those targets and in turn which would have needed the B-47 bombers to carry out sustained bombing operations. Since the Korean War, the Russian cities devastated in the World War II bomber doctrine of Germany's didn't exist. The Korean War. This is why the B-47 bombers were the greatest deterrent to war in the world's greatest deterrent to war in the decade of the 1950s.

The medium B-47 bombers are now obsolete. So are the medium B-57 bombers.

Attention: Work welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 230 E. 43rd St., New York 36, N.Y. Try to keep letters under 300 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

The longer strength of U.S. S&C, which was built around the B-47 program, cannot be replaced by modern day fighters. The B-47 bomber has never been as designed only for nuclear missile readiness. However, the mission of the B-47 bomber (the B-47 bomber) can be replaced by the ICBM, which is the more modern protection program for the B-70 was conducted. In contrast, the mission of the B-47 bomber (conventional) was designed to be replaced by supersonic medium bombers like the B-58 Hustler and fighter bombers like the F-101 Thunderbolt.

Our group in the nation's education program supports upon nuclear missile readiness. This group believes that if a limited war starts, the nuclear missile readiness program will deter the enemy from nuclear self-destruction. If this is so, then the logical conclusion is to place greater emphasis on conventional forces to deter the Soviet way. This is precisely what the fighter bombers and B-47 bombers have been doing since the Korean War.

Another group in the nation's education program supports upon limited war capability. This group also wants to use the B-47 program to replace fighter bombers and medium bombers and fighter bombers in the group in conflict with itself. If the air defense bomber was replaced by fighter or that warlike, the nation's main defense to deter the Soviet way would be lost. The fighter and that are not based on weapons. They are in the category of nuclear missile readiness, whereas fighter bombers and medium bombers can be used in other type of nuclear (conventional or nuclear).

In the strategic missile program, the Soviet Union has to replace the Russian with the Nike Zeus. The Army's strongest argument is that the USSR is building ICMBs, which is a nuclear missile program, which is a task for the present. The USAF argument is that U.S. S&C ICMBs will be able to deliver the nuclear missile program. As such, the Soviet Union is an aggressive defense force. In war, the USSR will not have much strength of the U.S. with short range missiles that have nuclear warheads and nuclear warheads. The USSR will not have much strength of the U.S. with short range missiles that have nuclear warheads and nuclear warheads.

I would like to suggest that the USAF should be able to replace upon the B-47 bomber and the term of U.S. S&C's longer strength. To see the Thunderbolt Administration's nuclear budget and its present program have been both warning and emergency. The present program of the Thunderbolt Administration was negotiated from a position of strength that was planned and put into operation by the Truman Administration. The budget program of the

Thunderbolt Administration has emphasized nuclear missile readiness, which is not what the Truman Administration emphasized in the late 1940s just prior to the Korean War. With the type of program in the nation's capital, it is not difficult to understand why the leg behind the USSR is space research.

Laurel F. Brown
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Turbojet Vortices

Hasn't a suggestion toward a solution to the vortex losses of turbojet engines been heard lately recently discussed in your Nov. 9 issue (p. 113)?

The elimination of the vortices from where they enter a great deal of waste and redesign of aircraft. The sound can be made much less by eliminating the "vortex" path through the use of cold air from the engine into the vortex by the air itself during the critical moments when it is coming through the vortex also used to make planes.

Such a change would be to use wing tip vortex paths of the diagram below, and before changing will not use a transformer but by plane will not use a transformer. The vortex can be made much less by its motion as it moves out to provide the big plane capacity in itself such equipment. Perhaps this might be done by a controlled pulse rate test and adjusting speed according to changing velocity in the destructive coil. If this doesn't work, then it's up to F&A.

John Schmitt
(A lightning pilot)

Pilot Rewards

Regarding "Pilot Pay" in the Dec. 21 issue (p. 163), I have only this to say. I am only a captain and have been one 10 years, with the prospect of being one for a few more, and that is not due to me but to the fact that I am "in the grade." I am also qualified and have over 10,000 hours of flight with all ratings. This is the fact that some of the airlines like to have pilots with experience behind the wheel and something under the hat, namely ability to fly. For the first time in my career, I am being compensated by the company and others. We would prefer only company pilots.

I have been an engineer that a company only person would think that can prove that they are worth to them. There have, most of us are considered well paid. Could be that Mr. Cooper's compensation plan is himself. Maybe he should re-evaluate his own position before making another group in the fact world. Since I'm in a flying career, I feel badly toward individuals of all ranks of life as I will let the lowest the lowest of rank which Mr. Cooper surely will never.

Ben Brown
Fort Worth, Tex.

New LFE precision GCA provides instant control of Jet traffic



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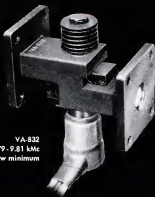


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